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ORIGINAL ARTICLES.

I.—On the Geologic Conditions affecting the Coasts of England and Wales, with special reference to the Coast-line from Lynn to Wells (Norfolk) and from Yarmouth to Eastbourne (Suffolk, Essex, Kent, and Sussex).

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Written for the Royal Commission on Coast Erosion and the Reclamation of Tidal Lands, and printed in its Report, 1907, vol. i, pt. ii, Appendices, pp. 141–5.

IN reprinting this article some slight changes and corrections have been made, but it remains substantially the same, perhaps with trifling improvements. [Any notable addition is included in brackets of this kind.]

During a long series of years I have examined a large amount of the English coast, either in the course of my work on the Geological Survey or in my holidays. This includes walking along the whole or nearly the whole coast of the following counties:—Norfolk, Suffolk, Essex, Kent, Sussex, Hants, Dorset, Devon, and Cornwall; a continuous series from the east to the south-west. To these may be added the small amount of coast possessed by Cheshire. I have also examined a considerable part of the coasts of Durham and Yorkshire as well as parts of the coasts of Somersetshire, Glamorganshire, Lancashire, and Northumberland. Generally speaking, every chance of seeing our coast has been taken. In some cases my walks were along the foot of the cliffs, in others along the top, often along both, and to many parts repeated visits have been paid. These facts are noticed in order to show that I have some experience of the subject.

General Statement as to the Sea-bord Counties.

It is clear that the form of a coast must depend on its geologic structure, and therefore so also must the rapidity of coast-erosion. Hard and firm rocks will resist the various eroding powers, whether from above or at the sea-level; soft and loose rocks will yield more readily.

It is not, however, altogether a question of mere hardness or firmness; many rocks of good character in that respect are seriously affected by structural planes, by which they are more or less readily

split up into large masses or even into small blocks. Faults, or planes along which the rocks have been displaced, are sometimes effective in this way; but far less so on the whole than the far more common planes of division (but not of displacement) known as joints. These are vertical or highly inclined to the bedding-planes (when the rocks are of sedimentary origin); there is often one dominant set, running in one general direction and therefore approximately parallel; but these master-joints are generally crossed by others at various angles.

The whole arrangement, therefore, of these divisional planes, which sometimes form narrow fissures, is one that favours the separation of the rocks into blocks, which may be more or less readily displaced.

In the case of sedimentary rocks the bedding-planes, that is the planes of deposition, may greatly assist in the destruction of even the hardest rocks.

It is not, however, the nature and structure of a rock that alone determine its rate of erosion. Its relation to other rocks is equally important; for instance, if a harder rock is overlain by a softer one, the resultant form of cliff will be what is known as slope over wall; the hard rock will resist the action of the sea at the foot and will form a more or less vertical cliff, whilst the soft rock will yield readily to the atmospheric agencies that are constantly in action above, parts of it being washed over or slipping over the cliff beneath, until the angle of rest is reached and a condition of comparative stability is gained. This form of cliff then is of the stable kind, depending on the resistance of a firm rock to the sea.

Where a harder rock is underlain by a softer one we get the form of wall over slope. The lower beds cannot stand with anything like a vertical face, but weather down to the angle of rest, modified as this may be by the softer bed having to support the harder one above. This form, therefore, is of an unstable kind, as the sea can readily wash away the yielding bed and so bring about the destruction of the hard overlying mass, from want of support. This, however, is one of those cases in which nature provides a check on her own destructive power; the blocks of hard rock that fall down the slope form a natural breakwater, hindering the sea from attacking the softer rock until they have been removed. There may, of course, be more than one slope or wall, in the case of alternation of harder and softer rocks, and the result will be a broken slope of considerable extent.

Another kind of alternation, that of permeable and impermeable rocks, is also important, as causing springs or general outflow of water along definite lines, thus adding to the slippery nature of the impermeable beds and facilitating the sliding down of the permeable beds above, which are often in themselves firm and resisting. Our great landslips are largely owing to this cause.

The direction of the dip in sedimentary beds is also a powerful factor in coast-erosion. Should that direction be in any way seaward, of course it favours the seaward slipping of the beds, hard or soft; but should it be landward it opposes an obstacle to such slipping, even in yielding beds, and delays the loss of land.

The kingdom of England and Wales is noted for the great variety of rocks that occurs on its coast and for the frequent changes from

one class of rock to another; both of which, of course, add to the complexity of the question of coastal waste. We have massive limestones, as the Carboniferous and Magnesian Limestones; alternations of shales or clays with sandstones, as the Upper Carboniferous; thick clays, with but little intervention of other rock, as those of the Jurassic Series and the London Clay; sands and sandstones, as parts of the Old Red Sandstone and of the Trias and the Upper Greensand; conglomerates, as that of the Permian; hard shales and slates, as those of the Devonian, Silurian, and Cambrian; alternations of clays, loams, sands, and gravels, as the Drift; the softer silts, peat, etc., of the Alluvial beds; and great sheets or long strips of shingle, deposited by the sea itself, together with tracts of sand, blown up by the wind from the shore, sometimes to a considerable height. Besides the above sedimentary deposits we have also granite and other hard igneous rocks.

Of all the geologic formations the chief cliff-formers are the Carboniferous Limestone, the Magnesian Limestone, the Jurassic beds (of various characters), the Chalk, the Drift (in Norfolk), the various Cretaceous beds below the Chalk, with the Wealden beds (on the southern coast), the Trias (Sandstones and Marls), the various Devonian beds and the Old Red Sandstone, the Granite of the far west, the Carboniferous beds of the west, and the hard Silurian, Cambrian, and Pre-Cambrian rocks of Wales.

We have also every variation in dip, from horizontal to vertical, and a great variety in the relations of the various beds; here a conformable orderly arrangement, there an irregular or a disturbed one; at one place a gradual change, at another a rapid or sudden one.

From the geologic standpoint alone, therefore, it is clear that the study of our coast is far from being a simple one.

Accretion of Land.

It is well known that there are various tracts where the land is gaining on the sea, and these are often instanced as if they more or less balanced the loss of land in other places. That they do this in the matter of area cannot be questioned; but I venture to say that this is all; that is to say, they do not, as a rule, in any way assist in the protection of the higher land against the destructive coastal actions. The fact is that almost all the gained land is below high water mark, and is largely protected artificially by banks. Moreover, it is largely in more or less sheltered positions. Exceptions to this will be duly noted; they occur where the sea has formed a large shingle-bank, sometimes accompanied by blown sand.

Perhaps the best example of gained land is that of the great flat bordering the Wash, which flat consists in part of the deposit of the rivers of the Fenland, and in part of silt brought in by the sea. Many hundreds of years ago this low land was far more flooded than now, when persistent effort during some centuries has gradually drained off the waters that once spread over great tracts and has defended those tracts by earthen walls. Moreover, the seaward face of this land has been gradually pushed forward by careful processes of enclosure, and the various old sea-walls can be identified

from Roman times onward. This gained land, however, does not aid in protecting the open coast; it is merely the infilling of a great hollow, and this infilling can never be carried beyond the coast-line, even if it ever reaches up to that. It is certainly valuable land, more so than much of that which is lost along the coast.

Another variety of accretion of land is where the sea piles up a mass of shingle, well above high water mark. This may form a strip along the coast (as in ordinary beaches); or may extend as a long slip between a river and the sea (as near Aldeburgh); or may form a broader tract, brought about by successive piling up of fulls or bars of beach to a considerable extent, so that the sea gradually forces itself outward from the land (as at Dungeness). [There is yet another rare mode of occurrence, where a beach (as the Chesil Beach) joins what would otherwise be an island to the mainland.]

Such tracts of shingle are, of course, of no value as ordinary land, but they have a great influence on the coast.

Crustal Movements that may be going on or which have occurred in late Geologic Time.

I can only say on this question that I know of no good evidence of movements now going on. But *there is clear evidence of such movements having taken place in late geologic times.* Thus the common occurrence of what have been called submerged forests shows that the land, at a very late geologic period, must have been a little higher than now. I object to the name given to these occurrences, as it seems to me misleading; there are no large forests, but only the occasional roots of trees and other remains of wood (see *post*). These, moreover, do not occur continuously along a great line of coast; so far as I know, they occur only in the neighbourhood of river-mouths. They are, in fact, nothing but a part of the alluvial flats of river-valleys, valleys that have been cut back by the advance of the sea, so that their latest deposits are shown at low water, where the valleys now end, that is, at the coast. These peaty beds really have no connection with the coast; they occur up the valleys also, and we have a notable instance of this in the Valley of the Thames, from London downward, where these beds have been laid open in the large excavations for docks and basins which have been carried to some depth below sea-level, or in the long trenches that have been dug for main drainage.

One of the most marked occurrences of such beds along a fair extent of coast is in the peninsula of Wirral, between the estuaries of the Dee and of the Mersey and on the other side of the latter, where the peat, crowded with roots of trees in the position of growth, can be well seen. The trees in these beds are of the same kind as those now growing in the country, and it is clear that they could not have grown in their present position, some feet below high-water mark: they must have lived when the land was at a slightly higher level than now. It is important to remember that they have nothing to do with the coast, but only with the river-valleys and their former extension. They occur in the case of small streams as well as in that of large

rivers, and have been observed and described wherever large dock-works have been made in the lower parts of river-valleys: elsewhere it is comparatively rare to find sections in Alluvium, the beds as a rule being not worth digging for economic purposes and moreover being dug into with difficulty, from their low position and consequent water-logged state.

Movement of upheaval, of rather earlier date, is shown by the occurrence of sea-beaches or terraces at levels approximately parallel with the present shore-line, but sometimes considerably above it. These often yield shells of like kind to those of the present coast, and so clearly prove a former difference in the relation between sea and land. Naturally such occurrences are confined to the harder rocks, the softer ones having been so cut back by the sea that all such remains have been carried away. In the South East of England there is no evidence of these beds, and, generally speaking, they occur only at a number of detached sites.

There is one point of caution, I fear not always attended to, in taking the evidence (as to rise of land) of a recent marine deposit above the present range of the tide. In heavy storms the waves can force up beach some way above the level of the water, and therefore it is possible that, on a coast being cut back, isolated masses of such piled up beach may be left perched on the top of a very low cliff, and may be thought to show rise of land, whereas in truth they do not, their isolated position being due to the gentle incline, which once reached from them to the beach, having been cut away, so that its higher inland end now alone remains.

I have seen, too, in the low part of the coast of Sussex (by Selsea) shingle that at one place shows a continuous slope up from the beach to the land, whilst some yards off a few feet of cliff separates this higher shingle from that at the base. In this case the shingle had been driven up through a farmyard, and therefore was distinctly modern.

Special Parts of the Coast.

As the parts to which I have been asked to give special attention have all been described in Geological Survey Memoirs, and the coastal changes noticed in those publications or in the Reports of the British Association Committee (some years ago), there is no need to go into great detail. Some parts, moreover, I have not seen for several years, and therefore have had to depend on information from other people as regards later changes. There is need indeed of resident observers in all districts where much change is going on.

From Lynn to Wells, Norfolk.

From Lynn northward to Hunstanton we are dealing with the eastern border of the Wash, and therefore for the most part with a district of accretion. During the three years of my residence at the former place, which ended in 1884, I got a detailed knowledge of this district and was able to record a large reclamation of land, since the publication of the old Ordnance map and partly made, near Lynn, whilst I was there. The Lower Greensand and the Drift beds that

fringe it in parts are here separated from the Wash by a strip of low alluvial land, down to the neighbourhood of Hunstanton Station, and along the northern part of this the Alluvium, in its turn, is bordered and protected by a strip of shingle, my few notes on which seem to have escaped publication.

At New Hunstanton, the watering-place on our eastern coast which faces westward, we have a cliff, for about 1½ miles, with Boulder Clay at the southern end, but mainly of Chalk underlain by the ferruginous carstone of the Lower Greensand, which last dips down out of sight at the northern end. The carstone makes a firm base and runs out along the foreshore as a rocky mass, separated into blocks along the planes of jointing. The Chalk, too, is fairly hard, and I saw nothing but very slight falls from the cliff.

From Hunstanton eastward there are no cliffs. The Chalk slopes gently northward and then, along the line of villages to beyond Burnham Deepdale, is covered by Drift (Boulder Clay and Gravel). This Drift must extend further north under the marshes, the outer parts of which are to some extent protected by bars of Shingle and Blown Sand. Further eastward, to and beyond Wells, the Chalk often reaches down to the Alluvium, though sometimes there is Drift between.

Along this somewhat peculiar coast there have probably been many changes in the shore-deposits, as may be seen by a comparison of the old Ordnance map with the new one. This also shows great shifting in the courses of the streams that flow through the low alluvial ground to the sea.

[The tract between Wells and Yarmouth was described by Mr. C. Reid, with much other matter, in pp. 163–172 of the Appendices to the Report.]

From Yarmouth to Eastbourne.

The long stretch of sea-bord now to be noticed gives some of the best examples that we have of the loss of land by coast-erosion, and it will be well to start with a short account of its geologic features.

Beginning at Yarmouth with the most recent beds (Blown Sand over Alluvium), for many miles southward we have nothing but Drift and Crag (which for our purpose may be grouped together). These consist here of Boulder Clay above (as far as Kessingland) with gravels and sands below, the thin clayey beds of the Upper Crag showing in places at or near the base.

From Gorleston to Kessingland the low cliff is breached only by the narrow valley of Lake Lothing, at Lowestoft; but southward of Kessingland the Alluvium of the many valleys reaches down to the beach to a considerable extent, so that we have but short lines of low cliff, attaining a length of about 2 miles southward from Dunwich (where too the cliff is higher than elsewhere) and of about 2½ miles from Sizewell to Thorpe.

Southward from Aldeburgh there is a change. We come to one of our great shingle-tracts, and for nearly 11 miles (measuring on the Geological Survey map) we have a strip of beach with the sea on one side and the River Alde on the other, a tract of slight accretion. A little

beyond this the London Clay appears for the first time in the cliffs, from beneath the Crag; and the Felixstowe cliffs also consist of Crag over London Clay. On crossing Orwell Haven to Harwich we have more than a mile of cliff of London Clay alone (Dovercourt). Thence marshes and tidal creeks set in, and alluvial clay comes down to the shore and also forms the foreshore to the Naze, which consists of London Clay, partly capped by Crag and Drift.

From Walton to Frinton we have more than 2 miles of London Clay cliff, and then, after an alluvial gap of a mile, some 4 miles of London Clay capped by gravel.

Westward and southward from this we have no cliff for many a mile. The marshes reach down to the beach as far as the estuary of the Colne. Mersea, between the Colne and the Blackwater, is a cliffless island. Between the Blackwater and the Crouch (more than 8 miles) we have generally a broad tract of marshes, the London Clay reaching to the coast only at one spot, on the north, the site of a Roman station (Ithanchester), and then not forming a cliff. From the Crouch to Shoeburyness there is again a tract of marshland, which is of considerable extent and mostly in the form of islands, owing to the River Roach and its attached creeks cutting through from side to side.

Westward from Shoeburyness, up the estuary of the Thames, there is at first a low-lying mass of gravel and loam, forming only a very small cliff in parts, with London Clay at the base sometimes. At Southend the ground rises and there are cliffs of London Clay to Leigh, where the marshes of the Thames begin.

Crossing the Thames there are again marshes, gravel and London Clay reaching the shore only north of Allhallows, and the latter again at the eastern end of the Isle of Grain.

Crossing the Medway to Sheppey, at and near Sheerness the marshes reach to the shore; but the London Clay soon rises up and forms cliffs of fair height along the greater part of the island, the highest parts having caps of Bagshot Sand and gravel. At the eastern end the marsh is separated from the sea by a beach of shells.

On the other side of the Swale, from Whitstable to beyond Herne Bay, we have some miles of London Clay cliffs, varied here and there by their coverings of gravel or loam. Then the Lower London Tertiaries (here consisting mostly of sand, but with some clayey beds in the lower part) rise up and at length reach the cliff-top three quarters of a mile westward of Reculvers.

The rise of the Chalk from beneath the Tertiary beds is hidden by the 2½ mile wide marshes of the Wantsum; but passing these we come to the Isle of Thanet, which is bounded almost wholly by chalk cliffs, there being a very few small gaps of Alluvium or Valley Drift; the thin cappings of loam in places are of no moment in this enquiry. In the lower ground westward of Ramsgate the Thanet Beds (sand and marly beds) come on over the Chalk somewhat suddenly and form a cliff for a short way.

Then southward, across the valley of the Stour, is a broad tract of marshland, bordered, from the river nearly to Deal, by a strip of Blown Sand (at one part over half a mile broad) with an outer margin of

shingle, which latter indeed is not covered by the sand at the northern end. Narrow here, this shingle widens at Deal and then reaches southward for 4 miles further, to Hope Point. Deal itself is partly on the shingle, partly on Alluvium, and partly on low-lying loam.

At Walmer the Chalk again comes to the coast and forms a line of cliffs nearly to Folkestone, these cliffs on the whole gradually increasing in height south-westward and being breached midway by the valley of the Dour.

We now pass to lower and lower beds. The Gault (clay) rises to the surface just north of Folkestone and forms a cliff for a short way. Then the sand of the topmost division of the Lower Greensand rises up at the harbour and forms the base of the cliffs, thence westward to Shorncliffe, beyond which there is no cliff for many miles.

The peculiar district now reached, that of Romney Marsh, etc., consists of a broad tract of alluvial beds, largely below high water mark and generally bordered by beach. The only parts rising above the ordinary level are formed of shingle, which here reaches far inland in places, Dunge Beach being, I believe, the largest area of shingle in the kingdom.

By reason of this great spread of Recent beds the formation that next underlies the Lower Greensand, namely, the thick mass of the Weald Clay, never shows at the coast here, being wholly hidden, and we have, therefore, no cliff-section to show us the details of its structure.

It is not till we get westward, nearly to Fairlight, that higher land is found. There we have the lowest beds of the Wealden Series (the Ashdown Sand) and the Fairlight Clays beneath, classed with the Purbeck Beds. These, with some overlying Wadhurst Clay, form the fine cliffs on to Hastings, and the like is the case with the cliffs of the Bexhill district, separated only by the Alluvium of the Catsfield stream.

Next comes the broad alluvial tract of Pevensey Levels, with its border of beach, the latter swelling out to a breadth of seven-eighths of a mile at Langney Point and then again decreasing in breadth to Eastbourne, where the Upper Cretaceous beds rise up, the Weald Clay being here again cut off from the coast and mostly hidden under the Alluvium, as also is the Lower Greensand, which, however, is here much thinner than on the Kentish coast.

(*To be concluded in our next Number.*)

II.—The Hill of Beath, a Volcanic Neck in Fife.

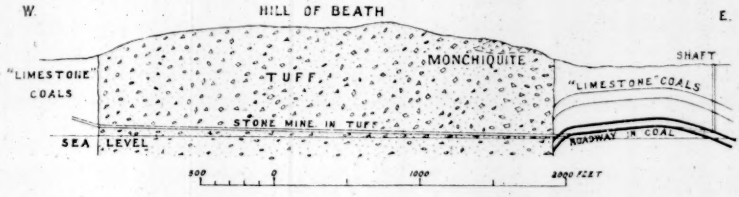
By J. S. Grant Wilson[1] & H. Brantwood Muff.

THE Hill of Beath, which lies 3 miles to the north-east of Dunfermline, Fife, is an isolated hill with steep, but rounded, contours, and rises fully 250 feet above the surrounding plateau. Whilst the hill itself consists of dark grey tuff, the rocks forming the

[1] On January 2, 1909, the Editor received the sad intelligence of the sudden death of Mr. J. S. Grant Wilson, who had only a few days previously communicated his MS. for publication in the Geological Magazine (see his Obituary, p. 91).

plateau belong to the Coal-measures of the Carboniferous Limestone series. The latter are thrown into gentle anticlines and synclines, the dip on the limbs of the folds usually lying between 10 and 15 degrees. The outcrop of the tuff has the form of an ellipse, the long axis of which trends east and west and measures nearly 1,000 yards, whilst the breadth of the ellipse is rather more than 500 yards. The distribution of the outcrops of the Carboniferous rocks around the hill and the evidence from the coal workings show that the tuff is not interbedded with the sediments, but that it breaks through them somewhat like an intrusive rock. Sir Archibald Geikie [1] recognized that the Hill of Beath was a volcanic neck, and this view has been confirmed by recent mining operations in a conclusive manner.

The Dunfermline Splint and Five Foot coals on the east side of the hill are worked in the Hill of Beath Colliery belonging to the Fife Coal Company. In order to reach the same seams on the north-west side of the hill a 'stone-mine' was driven in a westerly direction beneath the summit of the hill and almost along its greatest diameter. The stone-mine commenced at the foot of a roadway, which is partly cross-cut and partly 'dook' in the Dunfermline Splint coal, as shown



Section across the Hill of Beath near Dunfermline, Fife.

in the section, at a depth of 500 feet beneath the pit-mouth, or a little above Ordnance Datum. After driving a short distance the tuff was entered, and on plotting the underground position of the junction on to the 6 inch map it was found to be more than 550 feet vertically below the junction at the surface. The stone-mine was driven through compact tuff quite similar to that at the surface for about half a mile, and finally emerged into sedimentary rocks, the junction being vertical and almost perpendicularly beneath the margin of the neck as seen at the surface. The mine passed beneath the summit of the hill and at a depth of 700 feet beneath it, so that these mining operations have proved a vertical column of tuff piercing the Lower Carboniferous rocks and at least 700 feet high.

The eastern margin of the tuff against the sedimentary rocks is a typical neck junction, i.e. the beds as they approach the contact bend down sharply towards it. Whilst the general dip of the beds in the mine is about 10°, near the junction of the roadway with the stone-mine through the tuff the dip is 22° towards the neck. Eighteen yards further on it has increased to 50°, and 14 yards further it is 65°, and close to the contact with the tuff a dip of 74° was measured. This great increase in the angles of

[1] *Ancient Volcanoes of Great Britain*, vol. i, p. 425, footnote.

dip close to the tuff was also proved in the 'levels' in the Five Foot coal on both sides of the roadway. At the actual contact the shales are much crushed, dragged out, and slickensided, and the sandstones are shattered, but there is no sign of contact alteration, which sometimes occurs at the edge of other necks. On the western side the stone-mine has penetrated a massive white sandstone, which shows no signs of bedding, so that it is not yet possible to say whether the usual downward flexure of the beds takes place here also.

Further evidence of the behaviour of the tuff is afforded by the now closed down Halbeath Colliery, in which the coals were worked close up to the south wall of the neck, until they began to dip down towards it at an angle of 24°. At the south-east corner of the hill the coals were worked for a short distance vertically beneath the surface crop of the tuff, thus showing that the wall of the neck was here not vertical but inclined inwards. The angle of inclination, however, is not large. Thus the neck has not only been pierced from side to side and found to consist of volcanic tuff, but it is known to possess approximately vertical walls around more than half its periphery.

The cause of the characteristic downward flexure of the strata surrounding necks is not perfectly clear. The deformation must often have taken place very slowly, for massive beds of sandstone, etc., are in many cases bent without being broken, though in other instances the beds are fractured and displaced. Slickensides are frequently found on the walls of necks, and the clearest exposures closely resemble sections of a fault in which the strata on the upthrow side have been dragged downwards and the weaker beds crushed and drawn out. In the case of a neck the fault must be a circular one, the whole mass of material filling the neck having subsided bodily. If the subsidence were due merely to the consolidation and consequent contraction of the infilling volcanic rock, the amount of the flexure should decrease with the depth. This is not corroborated by the examination of neck-junctions underground. Sir Archibald Geikie points out that "after copious eruptions, large cavernous spaces may conceivably be left at the roots of volcanoes, and the materials that have filled the vents, losing support underneath, will tend to gravitate downwards, and if firmly welded to their surrounding walls may drag these irregularly down with them".[1] The phenomena at the margin of the Hill of Beath neck are very much what might be expected if such a subsidence had taken place. Though the surrounding sediments are dragged downwards, the tuff shows no signs of disturbance except near the margin, where it is cracked and the fissures occupied by calcite.

The material filling the neck is a palagonite tuff quite uniform in character throughout. It is composed of greenish vesicular lapilli scattered through a dull bluish-grey matrix, in which sand-grains can be made out. The lapilli vary in size from particles only just visible to the naked eye to fragments an inch or more across. The tuff is not stratified, strictly speaking, but it exhibits in the mine a broad striping due to bands containing large lapilli alternating with others made up only of smaller ones.

[1] Loc. cit., vol. i, p. 73.

A thin slice of a specimen from the mine shows under the microscope that the lapilli are irregularly rounded masses of greenish-brown palagonite, charged with cumulites and longulites, and without action on polarized light. Pseudomorphs in calcite after olivine are enclosed in some of the lapilli. The abundant, minute vesicles, which have oval shapes and are not often cut by the margins of the lapilli, are filled by zeolites or sometimes by chlorite. In some parts, however, the brown palagonitic substance shows faint aggregate polarization under crossed nicols, whilst the walls of the vesicles and of cracks show a fibrous structure, the very short fibres being arranged perpendicular to the walls.[1] This alteration is probably a secondary devitrification, and the vesicles in these altered parts are frequently occupied by calcite. In the dark matrix chips of quartz and felspar and minute particles of palagonite may be discerned, but the structure is in most parts quite obscure.

The numerous sand-grains in the tuff consist of angular and rounded particles of quartz, with some of microcline and plagioclase. These minerals are the chief constituents of the surrounding Carboniferous sandstones, and the grains in the tuff may have been derived from them, the concave curves bounding many of the angular quartz-grains being readily explained as the trace of fresh conchoidal fractures produced during the volcanic explosions which blew out the strata. But if the grains were really derived from the disruption of the Carboniferous sandstones, the absence of blocks of sandstone and shale is remarkable, unless it may be assumed that the rocks were not thoroughly consolidated at the period of vulcanicity. We refer later to the probability that the neck belongs to the age of the Upper Limestones, and supposing the volcano to have been a subaqueous one, the sand-grains may have been derived from the same source as the other Carboniferous sediments and deposited in the neck along with the truly volcanic material.

The lenticular mass of basic rock, which crops out on the eastern side of the neck, was not met with in the mine. The rock is decomposed at the outcrop, and its junction with the tuff is not well exposed, but probably it is intrusive into the tuff. It is a very fine-grained black rock, showing to the eye small, scattered phenocrysts of idiomorphic olivine altered to serpentine. Under the microscope an abundant second generation of idiomorphic olivine phenocrysts replaced by serpentine, reddish-brown strongly pleochroic biotite hexagonal in cross-section, and two or three small phenocrysts of pale green augite lie in a groundmass, which is charged almost to opacity by dusty magnetite, and is further obscured by spots of secondary calcite. In the thinner parts of the slide, however, one can see that the groundmass consists of minute prisms of augite, apparently pale green in colour, embedded in a clear, colourless, isotropic substance, which has a very low refractive index and is probably analcime. Recognizable analcime occurs in certain clear areas to be referred to below, and from these areas it appears to be

[1] Zirkel noted a somewhat similar alteration in palagonite tuff from Nevada. *Micro. Petro. Fortieth Parallel*, 1876, p. 274.

continuous with the base of the rock. There is no felspar. The rock has some affinities with the biotite-bearing limburgite of Carboniferous age from Whitelaw Hill, East Lothian, described by Dr. F. H. Hatch,[1] but it resembles more closely certain monchiquites of the same age from East Lothian to be described by Mr. E. B. Bailey in the forthcoming memoir on that district, and probably it is best termed an augite-monchiquite. Though evidently very basic in composition, it is too decomposed for the determination of the specific gravity to have any value, and further it contains numerous small, irregular vesicles filled with zeolites or calcite. There are also small but less well-defined spots free from magnetite. They are occupied by minute prisms of pale green augite embedded in analcime or calcite. Often the augite prisms form a distinct border on the periphery of the spot, the centre of which is occupied by calcite or analcime or both these minerals, whilst the biotite scales are sometimes very abundant in a narrow rim immediately outside the augite border. Though somewhat resembling the reaction-rims of augite, which surround xenocrysts of quartz in some basic rocks, these spots cannot be explained in that manner. Neither is there any sign of the regular crystallization of the augite in spherulitic fashion from a centre, or from points on the wall of the cavity. It is difficult to discriminate between two possible explanations. The spots might be due to an attempt on the part of the analcime to form definite crystals, which have succeeded in pushing away the magnetite and biotite, but the augite has only been collected on the borders. It is possible, however, that they are early-formed steam cavities, into which still unconsolidated parts of the magma have soaked and there crystallized out. There would be nothing surprising in the early formation of steam cavities in a rock containing a considerable quantity of analcime.

The age of the neck cannot be determined with absolute certainty. It must be younger than the rocks which it pierces, viz. the lower part of the Coal-measures of the Carboniferous Limestone series, but the higher limit of its age is indefinite. There are no bedded volcanic rocks in the neighbourhood with which it can be connected, but in the Saline Hills some 6 miles away in a west-north-westerly direction, similar tuff-necks are associated with bedded tuffs lying on the position of the Upper Limestones above the coal-bearing group, and Sir Archibald Geikie has classed the Hill of Beath neck with this group of Carboniferous puys.[2] The petrological evidence given above is in conformity with this correlation, for the monchiquite clearly belongs to the Carboniferous and not to the Tertiary igneous magma.

Amongst the many volcanic necks, between two and three hundred in number, which pierce the Old Red Sandstone and Carboniferous formations in the south of Scotland, several have had their subterranean extension proved by mining operations. Perhaps the best known cases are those in the Ayrshire Coalfield.[3] An instance in which a mine was driven from side to side of a neck, situated about 2 miles south-west of Muirkirk in Lanarkshire, is given in the "Explanation of

[1] Trans. Roy. Soc. Edin., 1892, vol. xxxvii, p. 116. [2] Loc. cit.

[3] Memoirs of Geol. Surv. Scotland, Explanation of Sheet 22, p. 25, and Explanation of Sheet 14, p. 22.

Sheet 23 (Scotland)", p. 39. Dr. Peach mapped a neck near East Grange, 5½ miles west of Dunfermline, the cross-section of which was ascertained in underground workings.[1] A somewhat similar case is that of Knock Hill in the Saline Hills.[2] The vertical extension of necks piercing the Calciferous Sandstone series has also been proved in the shale mines in the oil-shale field west of Edinburgh. Mr. H. M. Cadell[3] has described a remarkably good instance from the Broxburn oil-shale workings near Philipstoun (West Lothian). At a depth of 120 feet below the surface a mine was driven from a level in the Broxburn Oil-shale through the tuff of the neck into the oil-shale on the other side. The neck was 360 feet broad on this line of section, and the oil-shale on approaching the tuff dipped steeply towards it on each side. The walls of the neck were quite perpendicular and somewhat slickensided, like the face of a fault.

For information, and for giving us all facilities to examine the stone-mine through the neck, we are indebted to Mr. Henry Rowan, general manager of the Fife Coal Company.

III.—New Species of Cretaceous Bryozoa.

By Professor J. W. Gregory, D.Sc., F.R.S., F.G.S., University of Glasgow.

THE second volume of the Catalogue of Cretaceous Bryozoa in the British Museum, of which the manuscript has been completed, contains the description of various new Cretaceous species. Such a catalogue inevitably takes some months in passing through the press, during which it might happen that the species were anticipated by description elsewhere. To avoid the risk of reduplication of the names it is most convenient to publish the diagnoses. Fuller accounts of the species, with illustrations, will be given in the Catalogue.

Multitubigera, d'Orbigny, 1853.

Multitubigera sulcata,[4] n.sp.

Diagnosis.—Zoarium massive and thick. Radial ridges of each zoœcial sub-colony short, thick, and wedge-shaped. Apertures triserial to multiserial at the ends of the radii. The zoœcial colonies are elliptical, and usually separated by valleys or depressed porous areas, and not by definite regular laminæ.

Distribution.—Senonian—Maastrichtian: Maastricht.

Discofascigera, d'Orbigny, 1853.

Discofascigera vinei, n.sp.

Diagnosis.—Zoarium small, with a short, pointed base, covered by epizoarium. The upper surface is flat, with small raised marginal projections. In young zoaria the apertures are sparse and widely scattered.

Distribution.—Cambridge Greensand: Cambridge.

Fasciculipora, d'Orbigny, 1846.

Fasciculipora spicata, n.sp.

Diagnosis.—Zoarium with a narrow stem, widening into a thick horizontal expansion, from which rise numerous short, blunt fasciculi. The zoarium seen from

[1] *Ancient Volcanoes*, vol. i, p. 426. [2] Loc. cit., p. 435.

[3] "On an Ash Neck in the Broxburn Shale Workings at Philipstoun": *Trans. Edinburgh Geol. Soc.*, 1899, vol. vii, p. 477.

[4] So named on account of its furrows between the sub-colonies.

above is roughly triangular. The head includes about ten bundles of zoœcia, which rise upward in sharp spikes. The bundles are grooved longitudinally and branch dichotomously; the sides, when worn, appear punctate, but in well-preserved specimens are marked with longitudinal ridges, decorated by small points.

Distribution.—England—Chalk: South-east of England. Foreign—Senonian (Campanian): Ciply.

RETENOA,[1] nov. gen.

Diagnosis.—Theonoidæ with an erect frondose zoarium, composed of a network of dichotomous, anastomosing branches. The apertures all open on one face of the zoarium.

Type Species.—Retenoa campicheana (Orb.), 1853. Neocomian: Sainte-Croix, Switzerland.

HOMŒOSOLEN, Lonsdale, 1850.

Homœosolen gamblei, n.sp.

Diagnosis.—Zoarium frondescent, of crowded multipinnate branches. The branching is irregular; the branchlets cross and intersect, but do not anastomose. The back of the distal parts of the branches is traversed by longitudinal, fluted, or carinate ridges, which form a strong median carina: but this structure may be replaced by transverse wrinkling in the proximal ends of the branches in old specimens. Gonœcia ovoid; attached to base of the pinnules on the obverse face.

Distribution.—Upper Chalk (zone of *Micraster coranguinum*): Gravesend; Bromley, Kent. Middle Chalk (zone of *Micraster cortestudinarium*): Chatham. Also from Chalk, zones not recorded, at Charing, Kent; Salisbury; Guildford; Arreton Down, Isle of Wight.

Homœosolen virgulosa, n.sp.

Diagnosis.—Zoarium an erect, irregular tuft, which is repeatedly branched. The branching is irregularly dichotomous. The peristomal bundles are transversely elongated, and may occur in biserial ridges with as many as five apertures in each horizontal, transverse row. Some groups of apertures are irregularly triserial. Reverse surface fluted.

Distribution.—Chalk (zone of *Micraster cortestudinarium*): Chatham.

DISCOCYTIS, d'Orbigny, 1854.

Discocytis profunda, n.sp.

Diagnosis.—Zoarium very small, solid, pointed below, and expanding gradually or rapidly upward to an irregular but horizontal upper surface. The sides are coarsely ridged. Apertures in groups on irregular blunt knobs around the margin of the upper surface; seen from above the groups are radial and separated by irregular, small zoœcia.

Distribution.—Chalk: Charing, Kent.

DESMEPORA, Lonsdale, 1850.

Desmepora blackmorei, n.sp.

Diagnosis.—Zoarium of flat, broad branches. The apertures open on the ends of short, ridge-like lateral processes which project along the sides of the stems; these lateral processes are irregularly elliptical; the apertures are generally biserial with about eight in each row of a process, and the series are placed horizontally. The reverse surface is covered by crowded rows of small round pores (cancelli), and the surface is slightly concave.

Distribution.—Upper Chalk (zone of *Actinocamax quadratus*): East Harnham, near Salisbury.

[1] An abbreviation of *Rete-theonoa*, the theonid with a net-shaped zoarium.

Desmepora pinnigera, n.sp.

Diagnosis.—Zoarium composed of short, thick, somewhat swollen branches, which rarely subdivided and are frequently arranged in a cross. There may be five arms. The zoarium is attached by a short peduncle and base. The sides are marked by a series of ridges, which extend across the whole width of the side. Apertures arranged along the lateral ridges; the apertures are biserial or rarely triserial, and there are usually from five to seven in each row. Obverse face of the zoarium concave. The spaces between the raised groups are marked by rows of small, round pores (cancelli) between horizontal ribs.

Distribution.—Upper Chalk: Beachy Head; Dover; Burham, Kent; Sussex. Middle Chalk (zone of *Micraster cortestudinarium*): Chatham; Rochester. Lower Chalk (zone of *Holaster planus*): Dover.

Desmepora reussi, n.sp.

Synonymy.—*Desmepora semicylindrica*, von Reuss, 1872. Bry. Unt. Pläner: Palæontogr., vol. xx, pt. i, p. 123, pl. xxx, figs. 6 and 7, *non* fig. 8.

Diagnosis.—The branches are large, thick, and irregular, and form a short, stout, bushy zoarium. The peristomal groups project as large, blunt knobs; they are usually elliptical or subcircular, and contain from thirty to fifty apertures. They are scattered irregularly over the stems, being sometimes in the middle of the stems. Surface ornamented with long ribs.

Distribution.—Cenomanian—Unter Pläner: Plauen, Saxony.

TREPOSTOMATA.

Reptomulticava, d'Orbigny, 1853.

Reptomulticava canui, nov. nom.

Synonymy.

Reptomulticava tuberosa, d'Orbigny, 1854. Bry. Crét., p. 1036, pl. 791, figs. 13, 14.

non Alveolites tuberosa, Römer, 1839. Verst. norddeut. Ool. Nachtrag, p. 14, pl. xvii, fig. 9.

Diagnosis.—Zoarium massive, tuberous, with small, irregular tuberosities on the upper surface. Zoœcia with circular or elliptical apertures, and walls varying in width from one-fifth to occasionally one-half the diameter of the apertures.

Distribution.—Neocomian: St. Dizier and Vassy, Haute Marne.

Reptomulticava fungiformis, n.sp.

Diagnosis.—Zoarium fungiform with broad, short stalk, which may be hidden by the overgrowth of the broad upper surface of the zoarium. The side looks ringed by the overlap of the expanding upper layers. Zoœcia small; the apertures in well-preserved specimens are circular. About twelve apertures per sq. mm.

Distribution.—Lower Greensand: Farringdon; Upware.

Defrancíopora, Hamm, 1881.

Defranciopora libiformis, n.sp.

Diagnosis.—Zoarium of saucer-shaped or cup-shaped sub-colonies, with the base of one resting in the cavity of the sub-colony below. The rims are well rounded and wide. Apertures often in oblique series of three or four in a row, but in some parts of the zoarium the arrangement is irregular. The sides of the sub-colonies, except on the rim, are smooth and imperforate.

Distribution.—Senonian—Maastrichtian: Maastricht.

Ceriopora, Goldfuss, 1827.

Ceriopora farringdonensis, n.sp.

Diagnosis.—Zoarium nodular with tuberous upper surface, and may be subpeduncular below. The tubercles, which are sparse and low, pass into short, finger-shaped lobes. Surface smooth, but weathered specimens may look variolated owing

to the formation of depressions. Surface, when well preserved, covered in places by a thin calcareous epizoarium, which closes most of the apertures. Zoœcia of above average size; from twelve to twenty apertures per sq. mm. Walls thick and distinctly moniliform in longitudinal section. Diameter of zoœcia about ·2 mm.

Distribution.—Lower Greensand: Farringdon, Berks.

HETEROPORA, de Blainville, 1830.

Heteropora keepingi, n.sp.

SYNONYMY.

Heteropora (*Multicrescis*) *michelini*, Keeping, 1883. Foss. Neoc. Upware, p. 141.
non Ceriopora michelini, d'Orbigny, 1850. Prod. Pal., vol. ii, p. 143.

Diagnosis.—Zoarium tufted, rising from a thick base, giving off above thick, finger-shaped, simple branches, or knobby branches, which may divide irregularly; branches end bluntly. Mesopores uniserial, or sometimes biserial.

Distribution. — England — Lower Greensand: Brickhill, Upware? (*fide* Keeping); Coxwell and Farringdon, Berkshire; ? Isle of Wight. Foreign—Albian: Grandpré, Ardennes.

Heteropora clavata, Kade, 1852.[1]

SYNONYMY.—*Heteropora clavata*, Kade, 1852. Los. Verst. Schanzenb., p. 32.

Diagnosis.—Zoarium clavate, of a short stem which expands regularly upward into a pear-shaped mass. Transverse section irregularly elliptical, flattened on the side. Most of the surface is smooth, but the type-specimen is irregularly pitted. Zoœcia large, irregularly scattered. Mesopores large, a circle of five to seven around each aperture; and the circles of mesopores are confluent, so that but one mesopore or line of mesopores occurs between adjacent zoœcia.

Distribution. — England — Lower Greensand: Farringdon (Workhouse Pit), Berkshire. Foreign—Remanié in Drift: Schanzenberg, near Meseritz.

Heteropora subæquiporosa,[2] n.sp.

Diagnosis.—Zoarium funnel-shaped, composed of a thick layer around a hollow axis. Surface pustular, with irregular, indefinite tubercles or knobs. Mesopores large; in single lines between the apertures, but not well marked off from the zoœcia.

Distribution.—Upper Greensand: Warminster.

ZONATULA, Hamm, 1881.

Zonatula brydonei, n.sp.

Diagnosis.—Zoarium club-shaped, with a short, narrow stem and an egg-shaped head. The apertures of the zoœcia are circular or subcircular. They are divided into groups by alternate horizontal laminæ, which extend half-way across the apertures into alternate groups.

Distribution.—Lower Greensand: Farringdon, Berkshire.

DISCOCAVEA, d'Orbigny, 1853.

Discocavea reussi, n.sp.

SYNONYMY.—*Heteroporella collis* (*non* d'Orb.), von Reuss, 1872. Bry. unt. Quad. Elbthalg.: Palæontogr., vol. xx, pt. i, p. 133, pl. xxxiii, fig. 6.

Diagnosis.—Zoarium small, circular, convex, with a small central depression, on the floor of which are about fifteen apertures. Radial series of apertures numerous

[1] Kade's name is practically a list name, and the description is therefore included in this paper.

[2] Named from the comparatively slight difference in size between the zoœcia and mesopores.

and crowded, separated by only very narrow inter-radial furrows. About seven apertures in each ray. Apertures large.

Distribution. — Cenomanian—Lower Quader: Gamighügel, near Dresden; Kahlebusch, near Dohna, Saxony.

Discocavea longiradiata, n.sp.

Diagnosis.—Zoarium large, thin, circular. Zoœcia very numerous and apertures occurring in many (about forty) long rays, which each contain from about ten to sixteen apertures. No selvage. Inter-radii very narrow.

Distribution.—Lower Chalk: Southeram Pit, near Lewes.

Bimulticavea, d'Orbigny, 1853.

(Bry. Crét., p. 982.)

Bimulticavea simonowitschi, nov. nom.

Synonymy.

Ceriopora stellata, *pars*, Goldfuss, 1829. Petref. Germ., p. 85, pl. xxxi, fig. 1*c* (*non* figs. 1*a*, *b*).

Semimulticava goldfussi (*non* von Reuss, 1866), Simonowitsch, 1871. Bry. Essen Grüns.: Verh. nat. Ver. preuss. Rheinl., vol. xxviii, pp. 34–6, pl. i, figs. 3*a*–*d*.

Diagnosis.—Zoarium large, massive; Goldfuss' type is 45 mm. long by 18 mm. wide, with radial groups up to 6 mm. across. Each group has about eight spindle-shaped raised radial groups with biserial apertures.

Distribution.—Cenomanian—Grünsand: Essen.

Trochiliopora, nov. gen.

Diagnosis.—Radioporidæ with a simple top-shaped or capitate zoarium, composed of a constricted stem and expanded head. Apertures in vertical series on the margin of the head.

Type Species.—*Trochiliopora humei*, n.sp. Upper Chalk: Gravesend.

Trochiliopora humei, n.sp.

Diagnosis.—Zoarium fungiform, composed of a thick disc and stout, blunt stem. The diameter of the stem is nearly half that of the head. The lower end of the stem is longitudinally grooved, with linear pores. In the upper part of the stem the pores are irregularly arranged, and the intervening walls are reticular. Base of stem discoid. The upper surface of the disc is flat; its central portion is large, with numerous irregularly arranged apertures of young zoœcia. Margins vertical or well rounded, and marked by radial series of large apertures; there are three to four apertures in each series, and the series are separated by lines of cancelli.

Distribution. — Upper Chalk (zone of *Micraster coranguinum*): Gravesend.

Domopora, d'Orbigny, 1849.

Domopora colligata, n.sp.

Diagnosis.—Zoarium large and irregular; from the upper side it appears tubercular and massive. On a side view it is seen to be composed of numerous columns which are often attached, giving the zoarium a massive aspect like a *Radiopora*. The sub-colonies are distinct and thick. Apertures irregular in the centres of the sub-colonies, but become radial and vertical on the sides. In the lower sub-colonies the regular arrangement of the apertures is obscure, as most of the apertures in the vertical series are covered by the overgrowth of the upper sub-colony.

Distribution.—Lower Greensand: Farringdon, Berkshire.

Domopora vinei, n.sp.

Synonymy.

Domopora polytaxis?, *non* (Hag.), Vine, 1885. Cambr. Grnsd. : Proc. Yorks Geol. Soc., vol. ix, p. 21.
,, ,, ? ,, Vine, 1889. Further on Cambr. Grnsd., pt. ii: ibid., vol. xi, pt. ii, pp. 258, 270.
,, ,, ? ,, Vine. 1891. Rep. Cret. Polyz. : Rep. Brit. Assoc., 1890, p. 389.

Diagnosis.—Zoarium small, of two or more stems arising from a circular base. The stems are sharply divided by transverse annular constrictions into several segments, which decrease in diameter towards the blunt apex. Apertures in vertical series, containing from two to five in each series. The apertures in the series are in places well raised above the general surface of the stem. Mesopores scarce.

Distribution.—Cambridge Greensand : Cambridge.

Domopora virgulosa, nov. nom.

Synonymy.—*Ceriopora stellata*, *pars*, Goldfuss, 1829. Petref. Germ., p. 85, pl. xxx, fig. 12, *non* pp. 39 and 85, pl. xi, fig. 11 ; pl. xxxi, figs. 1*a–c*.

Diagnosis.—Zoarium sub-dendroid or tufted: it grows either in numerous short branches from a broad base, with the branches bifurcating occasionally, or as cylindrical branches, which may either give off above many sub-branches or expand distally into irregular lobes, or the main stem may expand into a thickened body giving off above small cylindrical stems. Sides marked by annular constrictions. The end consists of a group of crowded, irregularly arranged zoœcia, surrounded by the radial series, which pass into the vertical marginal series.

Distribution.—England—Upper Greensand : Warminster, and Chute Farm, near Warminster, Wilts. Zone of *Schlœnbachia rostrata* ; the Cutting, Black Ven, Charmouth. Foreign—Cenomanian : Essen. Lower Quader : Plauen, Saxony.

Domopora noraki, n.sp.

Diagnosis.—Zoarium usually clavate, with a large lobed head and annular peduncle, tapering towards the base ; but also found massive, with numerous stems rising from a broad encrusting base. Zoarium of many layers, up to about ten in number. Mesopores scarce, about as many or slightly more numerous than the zoœcia. Apertures, about six in each vertical series.

Distribution.—Cenomanian—Korycaner Schichten : Kamajk, Zbislav, Kolin, Kank, and Jiné, Bohemia.

Domopora cantiana, n.sp.

Diagnosis.—Zoarium small, of stems which are circular in section and marked by numerous horizontal annular constrictions. The upper segments gradually decrease in diameter, and the zoarium ends in a blunt point. Apertures in short vertical series, including from two to six apertures in a series. Mesopores scanty.

Distribution.—Upper Chalk (zone of *Micraster coranguinum*) : Bromley, Kent. Middle Chalk (zone of *Micraster cortestudinarium*) : Chatham.

IV.—Contribution to the Fauna of the Chalk Rock.

By Charles P. Chatwin & Thomas H. Withers.

(PLATE II.)

ALTHOUGH small examples of Ammonites are fairly common in the Chalk Rock (Turonian) of this country, large examples are decidedly rare. The only species of Ammonites as yet recorded from this bed are *Prionocyclus neptuni*, Geinitz, sp., and *Pachydiscus peramplus*, Mantell, sp. The former species is always of a small size and is not at all common, but small examples of the latter species,

averaging 1½ inches in diameter, are often found, and one large example measuring 8 inches across has been recorded by Mr. H. Woods.[1]

We have lately collected in the Chalk Rock at the Waterworks Quarry, Marlow, Bucks, two completely septate portions of a fairly large Ammonite which cannot be referred to either of the above-mentioned species.

In 1878 Bayle[2] instituted the genus *Puzosia*, but he gave no diagnosis of the genus, and although he refers to it the three species *Puzosia latidorsata*, Michelin, sp., *P. mayoriana*, d'Orbigny, sp., and *P. planulata*, J. de C. Sowerby, sp., he does not fix on either as the type of his genus, a fact which has given rise to much misunderstanding and confusion. The question has been discussed in a work by Mr. G. C. Crick,[3] who gave a diagnosis of the genus *Puzosia*, which is quoted below, and which we here follow.

Our specimens agree well with this diagnosis, and are therefore referred to the genus *Puzosia*.

Genus PUZOSIA, Bayle.

"Shell more or less umbilicated, with whorls more or less elevated; ornamented with forwardly inclined ribs which are continued over the rounded ventral area but are absent near the umbilicus, also with several forwardly-bent usually rather strong constrictions or varices. Suture-line similar to that of *Desmoceras* but more reduced; first lateral lobe longer than the ventral lobe, lobes trifid and relatively a little narrower than in *Desmoceras*, saddles almost alike, divided by a rather deep lobule into two parts, each of which is subdivided as in *Desmoceras*, several auxiliary lobes present, umbilical portion of suture-line dependent."[4]

The two specimens to be described are closely allied to the group of *Puzosia planulata*, J. de C. Sowerby, sp.,[5] the affinities of which are fully discussed by F. Kossmat.[6] He considers *P. planulata* as characteristic of the Cenomanian, from which horizon Sowerby's type from Hamsey in Sussex came. He, however, does not incline to the opinion that it has an extensive vertical range, and considers that the forms from the higher horizons belong not to the same but to allied species.

Our two specimens come from a much higher horizon than Sowerby's type, and although they are closely allied to *Puzosia planulata*, differ in some respects from that species. We therefore propose for these specimens, which in all probability belong to the same individual, the name of *Puzosia curvatisulcata*.

[1] H. Woods, "Mollusca of the Chalk Rock": Quart. Journ. Geol. Soc., 1896, vol. lii, p. 80.

[2] E. Bayle, "Explication de la carte géologique de la France," 1878, iv, Atlas, pls. xlv, xlvi.

[3] G. C. Crick, "Cretaceous Fossils of Natal.—I. The Cephalopoda from the Deposit at the North End of False Bay, Zululand": Third and Final Report Geol. Surv. of Natal and Zululand, 1907, pp. 209, 213.

[4] "That is, directed backwards, the lobes pointing across the whorl."

[5] J. de C. Sowerby, Min. Conch., 1827, vi, p. 136, pl. dlxx, fig. 5.

[6] F. Kossmat, "Untersuchungen über die Südindische Kreideformation": Beitr. zur Pal. und Geol. Österr.-Ungarns und des Orients, 1898, Bd. xi, Heft iii, p. 112.

Puzosia curvatisulcata, sp. nov. (Plate II, Figs. 1–4.)

Description.—Whorl very slowly increasing, laterally-compressed oval in transverse section, width three-quarters the height, indented to about a quarter of its height by preceding whorl, inner half of sides somewhat flattened, the outer half sloping gradually towards the periphery, periphery broadly convex, umbilical margin not very clearly defined, umbilical zone feebly convex, steeply inclined towards the umbilicus. There are no indications of the test, but on the anterior portion of the larger specimen (Fig. 1) are seen distinct indications of broad, feebly-convex ribs which are disposed in a forwardly-directed curve and which seem to disappear at about the middle of the sides. On both pieces a pronounced constriction is seen, being deeply, but not sharply, incised at the umbilical margin, whence it extends radially to about the middle of the side, where it becomes more shallow and assumes a forwardly-directed curve towards and over the periphery. The suture-line is well seen in the smaller specimen (Fig. 3), and is reproduced in Fig. 4. In the larger specimen only part of the external saddle, the first lateral saddle, and the intervening first lateral lobe are seen.

Dimensions.—Larger fragment is 64 mm. in length measured along the centre of the periphery. Height of whorl 55 mm. Height above preceding whorl 42 mm.; thickness 43 mm. Smaller fragment 46 mm. in length measured along the centre of the periphery. Height of whorl 36 mm. Height above preceding whorl 28 mm.; thickness 29 mm.

Affinities.—The species differs from *Puzosia planulata* in the curvature of the constrictions not being sigmoidal, and in the less prominent and more distantly disposed ribs. The flattening of the sides of the whorls in *P. planulata* extends nearer the periphery than in this species, and the slope of the umbilical zone is more steep.

In the Cretaceous of India several species of *Puzosia* occur, and Stoliczka[1] has recognized two varieties of *P. planulata*—(1) a strongly compressed form with fine ribs, (2) a thicker sub-species with stronger and less numerous ribs. Our specimens come nearer the former, which was separated by F. Kossmat[2] and referred to *P. gaudama*, Forbes, which is the only species found as high up as the Turonian. Compared with *P. gaudama*, the whorls in our specimens are much stouter and much more rounded on the periphery. The ribs are farther apart and less forwardly directed, while the constrictions assume a forwardly directed curve much nearer the umbilical zone.

Our best thanks are due to Mr. G. C. Crick for the advice which he has kindly given us in the preparation of this paper.

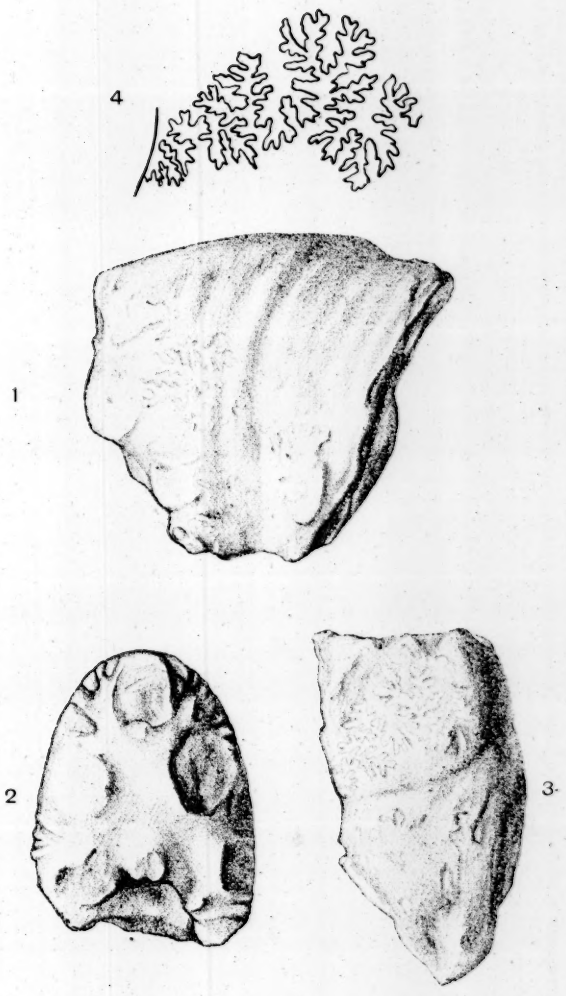
EXPLANATION OF PLATE II.

Puzosia curvatisulcata, sp. nov.

Fig. 1.—Part of a whorl, showing constriction and faint ribbing.
,, 2.—End view of same.
,, 3.—Part of a smaller whorl, showing constriction.
(These figures are $\frac{2}{3}$ natural size.)
,, 4.—Suture-line (natural size) traced from the original specimen.
Horizon.—Turonian—zone of *Holaster planus*: Waterworks Quarry, Marlow, Bucks.

[1] F. Stoliczka, *Cretaceous Fauna of Southern India* (Pal. Indica), 1865, vol. i, p. 134.

[2] F. Kossmat, op. cit., p. 116.



G. M. Woodward del.

Pazosia carratisulcata, sp. nov. Turonian zone of *Holaster planus*: Waterworks Quarry, Marlow, Bucks. Figs. 1–3, ½ nat. size.
Fig. 4, suture-line, drawn nat. size.

V.—Notes on *Phacops Weaveri*, Salter.

By F. R. Cowper Reed, M.A., F.G.S., Sedgwick Museum, Cambridge.

A RE-EXAMINATION of the type-specimens of *Phacops Weaveri*, Salter,[1] in the Museum of Practical Geology, Jermyn Street, was recently rendered necessary in connection with my palæontological work on the Tortworth Silurian area, the results of which have been published in the November number of the Quarterly Journal of the Geological Society, 1908 (vol. lxiv, pp. 512–545), in a joint paper by Professor S. H. Reynolds and myself. A question had arisen in the course of our work as to the occurrence of this species above the Llandovery Beds, for Salter had stated that some of his figured specimens of pygidia (Mon. Brit. Trilob., pl. iii, figs. 2, 3) came from doubtful Ludlow rocks at Horse-shoe Farm, Tortworth. The species had, however, been founded by him previously on specimens from so-called 'Caradoc' [= Llandovery] rocks from Long's Quarry, Tortworth,[2] and an outline figure of the pygidium, apparently a restoration based on the three specimens in Jermyn Street (Nos. 19220, 19221, 19222), had then been given. Subsequently a head-shield from the same quarry was figured in his monograph (pl. iii, fig. 1). It is clear that Salter based the species mainly on the pygidial characters, for the head-shield is dismissed with a few inadequate remarks, its resemblance to *Ph. caudatus* being considered to be very close. The original description given by Salter in 1849 runs as follows:—"P. laevis, capite quam in *P. caudato*, nisi lobis glabellae tumidioribus;—caudâ triangulari, ferè aequilatera, convexa, apice acuto haud mucronato, axi 13–16 annulato, costis lateralibus 10–12, simplicibus, vix curvatis, ad marginem aequalem angustum abruptè terminatis." In the diagrammatic figure of the pygidium which accompanied this description only 12 or 13 rings are indicated on the axis and 10 or 11 ribs on the lateral lobes, which might incline us to think that an immature individual was chosen for the figure, since Salter in his remarks on the species says (op. cit.) that "young specimens have not the full number of ribs", but no mention that this is the case is found in the explanation of the plate. In Salter's subsequent work (Mon. Brit. Trilob., p. 58) the tail is described as "broad-triangular, wider than long; the sides a little convex; the apex short-mucronate; the axis narrow, conical, ribbed by about sixteen rings; the sides very convex with *nine to ten* arched simple ribs scarcely at all interlined; the margin [=border] narrow, smooth". The italics in this quotation are mine, as the number of ribs is fewer than that given in his earlier definition of the species. It may here be remarked that Salter in his monograph reproduces verbatim the definition of the species published in the decades, with the addition of the word *trigono* with reference to the head before the word *nisi*, and with the insertion of the epithet *multicostata* after the word *æquilatera* in the description of the pygidium.

[1] Salter, Mem. Geol. Surv., 1849, dec. II, art. 1, p. 7, pl. i, fig. 16; Mon. Brit. Trilob., 1864, p. 57, pl. iii, figs. 1–3; pl. iv, figs. 6–9.

[2] The site of this quarry in the Llandovery rocks has been fixed with much probability by Professor Reynolds (op. cit., p. 514).

Salter at this time admitted that his knowledge of this species was but slight, and though he believed that all the specimens which he figured belonged to one species, yet expressly stated that he "would prefer to keep the name for the fossil of the May Hill Sandstone". Moreover, as the specimens from the doubtful Ludlow rocks of Horse-shoe Farm, figured in his monograph on pl. iii, figs. 2, 3, were attributed by him to a "larger form of the species", it is clear that Salter's intention was to regard the specimens from Long's Quarry (of May Hill Sandstone age) as the typical form. Accordingly, it is on the characters of these latter that the species must rest.

The pygidium is figured in the decade ii, pl. i, fig. 16, somewhat incorrectly and diagrammatically as above mentioned, but only one (No. 19221) of the three specimens in Jermyn Street seems to have been used in the much more accurate figure given in his monograph, pl. iv, fig. 7. The head-shields from the same horizon were illustrated by two figures in the monograph on pl. iii, fig. 1, and pl. iv, fig. 6.

Of the three examples of the pygidium two are internal casts (Nos. 19221, 19222) and the other (No. 19220) an external impression. The shape of these pygidia is parabolic; the length of the type (No. 19221) is about 11 mm. (but the posterior margin is rather imperfect) and its width 14–15 mm.; the length of its axis is about 10 mm. and its width at its front end 5 mm., and it tapers regularly at about 20°–25° to its bluntly pointed extremity. Though the posterior margin is not clearly preserved in this specimen, so that its mucronate or non-mucronate character cannot be decided, yet in the external impression (No. 19220) from Long's Quarry, and especially in another specimen in the Wyatt-Edgell Collection from Tortworth in precisely the same rock, it is found to be not acutely pointed nor mucronate, but obtuse and rounded, as indeed Salter rightly shows in his figure (pl. iv, fig. 7). With regard to the axis in specimen No. 19221, only the anterior two-thirds or three-fourths are distinctly annulated, being composed of 8 complete rings, but the posterior part (which is, however, somewhat abraded) shows 5–6 faint incomplete rings. In the external impression (No. 19220) 14–15 rings can be counted on the axis, but the last 3 or 4 are indistinct. The total number of axial rings, therefore, is 13–15.

The lateral lobes are gently convex, as Salter mentions, but possess only *eight* ribs. Salter's figure (Mon., pl. iv, fig. 7) shows only this number in spite of the greater number given in the description. These ribs are gently and regularly curved, and successively decrease posteriorly in length and strength, the last pair being very short and nearly parallel. All the ribs seem marked with a very faint, fine, submedian line for about three-fourths of their length, and this feature is especially well seen in the external impressions. In the internal casts the ribs are separated by interspaces (interpleural furrows) as wide as the ribs themselves, but in the external impressions it is seen that these interpleural furrows are really quite narrow. The ribs and furrows end abruptly against the border, which is smooth and narrow, but definite; and in the best preserved examples it is clear that it does not appreciably widen behind and that it is not

furnished with a mucro. The eight ribs of the lateral lobes correspond with the first 8 rings of the axis, the posterior annulations of the latter thus having no corresponding ribs.

The head-shield from Long's Quarry (No. 19223 in the Jermyn Street Museum) which Salter figured in his monograph on pl. iii, fig. 1, is imperfect on the left side. Its length is about 14 mm., of which the frontal lobe of the glabella accounts for 8 mm.; this lobe is 12 mm. in width and projects a little laterally, and has a well-marked elongated pit in the median line, as Salter represented in his figure but did not mention. The first lateral lobe has a somewhat greater length along the axial furrow than Salter's figure shows. The second and third lateral lobes are of equal size. The first lateral furrow runs inward at about 50°–60°, and the second and third lateral furrows, which are parallel to each other, at about 70°–75° to the axial furrows. The eye-lobes are rather larger and longer and the eyes rather less curved and rather nearer the glabella than in typical examples of *Ph. caudatus*, but except in these details there does not appear to exist any marked difference.

With regard to the pygidia, which Salter described and figured (Mon., p. 58, pl. iii, figs. 2, 3) as the "larger form of the species", from the so-called Ludlow rocks of Horse-shoe Farm, Tortworth,[1] we may note several important points of difference from those just discussed. Both are preserved in the same matrix and are considerably larger than the others; one of them (op. cit., fig. 2), though imperfect, possesses a length of about 25 mm., and is estimated to have had a length originally of 38–40 mm. with a rather less width; the other (op. cit., fig. 3), which is also broken, now measures 35 mm., but when perfect its length must have been at least 50 mm. Moreover, from the contour of the margin near the posterior extremity of each specimen there is every indication that the border was produced behind into a mucro, though the length of the latter cannot be determined.

From the specimen represented in Salter's fig. 2 the shell is missing, except near the right margin, where its surface is seen to be minutely and regularly granulated. This is not shown in the figure or mentioned in the text. Only the right half of the pygidium is present; the axis tapers very gradually so far as can be seen, and shows 15 distinctly marked rings with traces of a 16th, followed by a non-annulated piece extending to the tip of the axis, and equal in length to about the last four rings. The transverse furrows between the rings are weak in the centre but deeply impressed at the sides. There are 13 ribs on the lateral lobe, counting the anterior marginal one, and the first 11 ribs correspond with axial rings; the ribs are gently curved back and are somewhat flattened on the surface, and are rather broader than the wide interspaces or furrows between them. The anterior face of each rib is obliquely bevelled, but the posterior face is nearly vertical. The 2nd to 4th ribs have a very faint median impressed line traceable along three-fourths of their length. The last lateral rib is very short and weak, and lies nearly parallel to the axis.

[1] Reed & Reynolds, op. cit., p. 524.

In the case of the second figured example (fig. 3) from Horse-shoe Farm, Salter's figure does not correctly represent nor do justice to it. The shell is missing from the whole specimen. The axis is very long and narrow, tapering very gradually, but owing to the loss by fracture of a part of its anterior end, its length cannot be measured accurately, and its left side also is hidden in matrix. The first two rings, corresponding to the first (marginal) and second ribs of the lateral lobe, are broken off, but there are 13 rings behind and traces of a fourteenth, making 15 or 16 in all. There are 11 ribs preserved on the lateral lobes, and these ribs are not sickle-shaped as Salter's figure represents, but are simply and gently curved back; the first 10 correspond with axial rings, the 11th starting apparently from the level of the 14th axial ring. That there were more ribs behind is probable but uncertain, as this posterior portion of the pygidium is imperfect. The interspaces or furrows between the ribs are rather wider than in the other specimen, and each furrow expands somewhat at its outer end into a blunt, rounded termination, but does not thin out as Salter's figure incorrectly shows. Near the outer ends of the 2nd to 9th ribs there is a trace of a faint median impressed line, but this "interlineation" does not show so plainly or extend so far as Salter indicates. The border of the pygidium is very slightly swollen, but not raised above the general level of the ribs, which pass into it without any demarcation. The width of the lateral lobe preserved is 21 mm.; the outer half is gently arched down, but the inner portion is flattened and nearly horizontal.

These two specimens may be referred to one and the same species; but this species must be considered distinct from the other form which occurs in the Llandovery of Long's Quarry. They are both separable from *Ph. caudatus*, as Salter pointed out (Dec. ii, art. 1, p. 7), by the more numerous ribs (*Ph. caudatus* having only 6–8) and by the ribs not being duplicate. Salter, moreover, remarks that the fact that "the margin is equal all round and not expanded or mucronate at the end" is another point of difference from *Ph. caudatus*, but this non-mucronate character is only found apparently in the Long's Quarry figured specimens, as we have seen that there is reason to believe that the Horse-shoe Farm "larger form" was furnished with a mucro. Indeed, from his attempt to combine in his definition the characters of these two types of pygidia it results that Salter's description is strictly applicable to neither in every detail, and confusion has thus ensued.

The differences between the typical Llandovery form of Long's Quarry and the Ludlow (?) larger form of Horse-shoe Farm are that the pygidium of the latter is relatively more elongate and pointed, the posterior end is probably mucronate, the axis tapers more gradually and has more numerous annulations, and the lateral lobes are flatter and have more numerous (11–13) ribs upon them. It scarcely seems possible to regard these differences as of less than specific value, and the name *Ph. Weaveri* must be restricted to those specimens agreeing with the type from the Llandovery of Long's Quarry.

In his monograph (pl. iv, figs. 8, 9) Salter attributes to *Ph. Weaveri* certain specimens from Marloes Bay. They are in a completely

different state of preservation to those from the Tortworth district and are somewhat crushed, distorted, and imperfect, so that their identity with *Ph. Weaveri* must be regarded as doubtful. The larger specimen of the pygidium (op. cit., fig. 8) shows 10 complete and distinct rings on the axis followed by 4 or 5 small and very weak rings; the lateral lobes possess 9 distinct ribs, of which the first 8 correspond with axial rings; the margin is not preserved and the border is broken. The smaller specimen (fig. 9), except for the presence of a short mucronate extremity, has practically all the characters of the Tortworth typical form. Probably these Marloes Bay specimens may be regarded as a local variety, but the material is too indifferent and scanty for the satisfactory decision of this point.

From the above detailed re-examination of all Salter's figured specimens which he referred to one species, *Ph. Weaveri*, we find that his definition of this species requires emendation, and though we cannot give a precise and full description of the head-shield, yet with regard to the pygidium on which the species was founded the following summary of its characters may be substituted:—Shape parabolic, wider than long, rounded behind, not mucronate; border smooth, of subequal width all round, not produced into a point. Axis conical, tapering regularly at about 20°–25° to obtuse tip, annulated for whole length, with 8 complete strong rings corresponding to the ribs, followed by 4–7 much narrower weaker rings. Lateral lobes gently convex and arched down, composed of 8 slightly curved ribs, successively decreasing in size posteriorly and the last pair subparallel, marked by fine submedian furrow for greater part of length, separated by narrow interpleural furrows, ribs and furrows ending abruptly inside border. (Figured by Salter, Mon. Brit. Trilob., pl. iv, fig. 7.)

This is the common species of *Phacops* in the Llandovery rocks of the Tortworth area. I have examined a large series of specimens collected by Professor S. H. Reynolds from the Llandovery Beds of this area in the course of his stratigraphical work, and they are all of the type of *Phacops Weaveri* as here defined. Excellent pygidia from Damery Bridge, Daniel's Wood, and the site of Long's Quarry agree precisely with those from Long's Quarry used by Salter in drawing up his inaccurate diagnosis, and with the specimen accurately figured in his monograph (pl. iv, fig. 7). There is, therefore, not the least doubt now as to the true characters of the pygidium, and it has been above shown that it is on this member of the body that the species rests. The new and emended definition which I have here given must accordingly be in future regarded as expressing the specific characters of *Ph. Weaveri*. As regards its systematic position, it must be placed in the subgenus or section *Dalmanitina* proposed by the author in 1905[1] for certain members of the genus *Dalmanites*, if we separate the latter generically from *Phacops*, as seems justifiable and natural, though this practice has been rarely adopted by European palæontologists.

[1] Reed, Geol. Mag., Dec. V, Vol. II, 1905, pp. 172–178, 224–228.

VI.—Notes on the Graptolite-bearing Rocks of New Zealand.[1]

By E. Douglass Isaacson, F.G.S.

THE series of beds containing graptolites in New Zealand occur in the Whakamarama district, which is situated in almost the extreme north-west of the South Island. They consist of intercalated bands of quartzite and carbonaceous argillites, with a north and south strike and dipping at a low angle to the west. As a result of the natural erosion of the land surface taking place more rapidly in the slaty layers than in the harder quartzites, the ridges and stream valleys exhibit a noticeable parallelism, those streams which enter the sea on the western coast usually taking a very sharp bend to the west, and with a somewhat gorgy channel to the sea. The valleys are for the most part densely clothed with forest trees, while the ridges of quartzite are barren, with the exception of a stunted growth of *manuka* (*Leptospermum scoparium* and *L. ericoides*), and in places a covering of peat to a depth of a few inches.

The deposition of the sediments has been characterized by somewhat sharp changes, due no doubt to the alternate elevations and depressions of the ocean bed, which appear to have succeeded each other somewhat rapidly about this period. Neither the beds of quartzite nor the argillites are of any great thickness, and have an approximately equal development.

In the argillites fossils have hitherto been found only in the neighbourhood of the auriferous reefs of the Golden Ridge, Whakamarama, and are restricted to a band of carbonaceous argillite which constitutes the walls of the reef in this locality. As at Bendigo, Victoria, the graptolite beds are in intimate association with the auriferous reefs, and, moreover, the prospecting for fresh reefs in this locality seems to point to the fact that their intimate association is necessary for a payable reef to be discovered. The argillite bed is some hundred feet thick, and includes a band more highly graphitic than the remainder from which the fossils are obtained. Owing to the inaccessibility of the country and the absence of outcrops, the fossiliferous beds have not yet been by any means fully investigated, and it is highly probable that further work may yet lead to important discoveries. The argillites have a somewhat schistose appearance from the parallel plates of graphite, the other component being fine silica in a cement medium.

Though not hitherto discovered *in situ*, an interesting rock-specimen obtained in this locality by the author was a spotted slate, which under the microscope was observed to contain excellent crystals of chiastolite with carbon inclusions arranged in a cruciform manner. This rock probably was a result of thermal metamorphism, caused by the intrusion of a granite boss to the southward, and is a rare instance of this change in the country. The quartzites, variously also termed chert and grauwacke by different authors, consist almost entirely of a mosaic of subangular quartz-grains. As mentioned above, the graptolites have up to the present only been

[1] See paper by Mrs. E. M. R. Shakespear, D.Sc., "On some New Zealand Graptolites," Geol. Mag., Dec. V, Vol. V, April, 1908, pp. 145–8.

obtained from Slaty Creek and its branches, where they occur in a carbonaceous argillite, the outcrop bending round on itself in a horse-shoe form of which the longer or westerly limb has hitherto been unexplored. Nor have any fossils been as yet obtained from the extreme southward extension of this limb. In some parts the replacement of the chitin of the fossils by pyrite is somewhat common, rendering the structure obscure.

Dr. Bell[1] evidently considers that the New Zealand graptolites occur at one horizon, which view, however, is not upheld by Dr. Shakespear (loc. cit., 1908), who points out that there are two zones which are both lithologically and palæontologically distinct. The specimens examined by Dr. Shakespear were obtained from three points extending along a valley for some half-mile. The most southerly of these supplied only the coarse-grained argillite called the *a* type, while the other two localities supplied both types *a* and *b*. In this half-mile or so of valley the dip of the stratum changes considerably, being some 60° at the southern locality to 30° at the northern, the bed becoming almost flat as the summit of the syncline is reached.

The fossiliferous bed is itself but a few inches thick, and is characterised by being more graphitic than the accompanying slate; and though the bed cannot be traced from one fossiliferous locality to another, yet considering together the change in the strike and the elevation of the places above the level of the creek, the weight of evidence seems to point to the bed being continuous from one place to another, and that only the one bed is present.

Again, since both types are present in a band but a few inches thick, and if each type is considered representative of a different zone, then between the period of each zone the deposition of the sediments has been almost, if not altogether, suspended. Of this there is a total lack of local evidence.

It seems highly probable, then, that the horizons have succeeded each other so rapidly that the remains of the two are almost in juxtaposition.

VII.—The Mechanics of Overthrusts.

By T. Mellard Reade, F.G.S., A.M.I.C.E.

MR. OSMOND FISHER, in an article in the January number of this Magazine, entitled "Convection Currents in the Earth's Interior", speaks of my views in a way that may give a false conception of what they are on the subject of overthrusts. He appears (inadvertently, no doubt) to credit me with a disbelief in the thrust-planes occurring in the North-West Highlands. I may say at once that I am one of those who admire the way in which a band of enthusiastic geologists have worked out the structure of this most difficult tract of country, and thoroughly believe in the correctness of their conclusions.[2] The principal object of my little paper in the

[1] Bull. N.Z. Geol. Survey, 1907, No. 3.

[2] Memoirs of Geological Survey of Great Britain: "The Geological Structure of the North-West Highlands."

November number of this Magazine (1908) was to caution geologists not to push their new-born views too far in trying to account for structural difficulties by overthrusts. It must be remembered that the Moine thrust-plane has been proved to no more than 10 miles overlap, but may, of course, be much more. Incidentally, I thought the paper likely to elicit a correspondence helping the interpretation of the phenomena of overthrusts.

Perhaps the following considerations may be helpful to those geologists interested in the subject.

It may be contended that the Alps, having been compressed, according to Heim, 78 miles, have been moved that distance over the underlying rocks, and that therefore the power exerted to obtain that effect is even greater than is required to create a thrust-plane such as I have postulated, viz. 100 × 100 miles. Mountain building, I contend, is not a parallel phenomenon, the building going on in sections, and the mountain range being as it were modelled by the pressure applied at different times in different localities, not by one general movement. Internal variable strains are continually taking place, and it is to these that the mobility seen in mountain structure is due. The very name 'building' is suggestive of the process of addition, or brick on brick erection, Nature being both architect and builder. It may be seen from this that the repeated pressures applied in sections may have a general cumulative effect and constitute yet another of those examples so often seen in nature where enormous results arise from the repeated application of small forces. If it could be demonstrated how fracture could have arisen by the cumulative effect of small agencies, it would bring us nearer to belief in the theory that transference of enormous masses of rock has been effected by overthrusts.

Mr. Fisher has ably restated his well-known theory of convection currents in the earth's interior. It seems, however, to me to be one unlikely to provide the lateral pressure in the form and amount wanted to create a thrust-plane.

REVIEWS.

I.—Monograph on the Higher Crustacea of the Carboniferous Rocks of Scotland. By B. N. Peach, LL.D., F.R.S., A.R.S.M. Memoirs of the Geological Survey of Great Britain: Palæontology. 4to; pp. 82, 12 pls. 1908.

THERE is perhaps no group of fossil Crustacea of which the study promises more important results for morphology and phylogeny than does that of the primitive Malacostraca of the later Palæozoic periods. There is reason to hope that it may yet be possible to trace among them the differentiation of some of the existing orders from the common stock of the Malacostraca. Dr. B. N. Peach published important memoirs on the higher Crustacea of the Scottish Carboniferous rocks nearly thirty years ago,[1] and since his retirement from the service

[1] See B. N. Peach, Trans. Roy. Soc. Edinb., 1882 & 1883, vol. xxx, etc.

of the Geological Survey, in 1905, he has resumed his study of the subject, and has set forth the results in the elaborate monograph now before us. It is based on the examination of upwards of 2,000 specimens, some of which are in an exceptionally fine state of preservation, so that Dr. Peach has been able to recognize and describe structures so delicate as the gills, and even, he believes, the phosphorescent organs (photospheres) of certain species. Those who have puzzled over the almost indecipherable fragments by which these Crustacea are usually represented in the rocks will appreciate to the full the patience and skill which Dr. Peach has devoted to their interpretation, and will hesitate before they venture to dissent from his conclusions. After due hesitation, however, some dissent must be expressed.

Forty-two species and varieties are described, of which twenty-three are new, and they are referred to nine genera, of which four are here established for the first time. Among the new genera the most important perhaps is *Tealliocaris*, of which the abundant and wonderfully well-preserved material has enabled Dr. Peach to give a very detailed account.

Dr. Peach concludes that all the forms with which he deals are to be referred to the 'Schizopoda', and not, as had been supposed in the case of some of them, to the Decapoda. In doing so he makes no reference to the more recent views on the classification of the Malacostracous Crustacea, which are based on the work of Boas, Hansen, and others. According to these authorities the 'Schizopoda' form a heterogeneous and unnatural group, comprising the more primitive members of at least three widely divergent branches of the Malacostracan stock. It is quite probable that these branches were much less sharply differentiated in the Carboniferous period than they are now, and the retention of the name 'Schizopoda' as a convenient term for the unspecialized ancestral forms which cannot be included in any of the orders of living Malacostraca may perhaps be defended; but it seems to us that a consideration of the results of recent work on this question suggests caution in accepting many of Dr. Peach's conclusions. On one point at least there can hardly be any dispute; the characters assigned to several of the fossils make it quite impossible to refer them, as Dr. Peach does, to the *families* of existing Crustacea. Thus, for example, the genera *Anthracophausia* and *Crangopsis* are described as having the carapace loosely enveloping the thorax but not coalescing with more than one or two of the anterior somites on the dorsal side; yet these genera are referred to the Euphausiidæ, in all the living forms of which, as in the Decapoda, the carapace coalesces with the terga of all the thoracic somites. Ortmann has already drawn attention to this character in *Crangopsis*, and suggested that the genus should be referred to the Mysidacea, or rather should be regarded as intermediate between the existing members of that order and the more primitive Malacostraca. If Dr. Peach's identification of the male sexual appendages on the first pleopods be correct, *Crangopsis* would seem to combine characters of both the Peracaridan and Eucaridan divisions of the Malacostraca, and must be excluded from all the existing orders. It is by no means clear, however,

that all the species of *Crangopsis* described in this monograph are congeneric. In certain of the fossils it is plainly seen that the pleural plates of the second abdominal somite are expanded to overlap the plates in front and behind. Now the only Crustacea which exhibit this character are the members of the tribe Caridea among the Decapoda; and while it would be rash to assert, without examination of the specimens, that these are really Caridean Decapods (not hitherto identified earlier than the Upper Jurassic), the character deserves more consideration than it has received.

Space does not permit of further discussion of the numerous points of interest contained in this very important memoir. It deserves careful study not only by palæontologists but also by students of the phylogeny and classification of recent Crustacea, and the veteran palæontologist of the Scottish Survey is to be congratulated on its production.

The way in which this memoir is issued shows little regard for the convenience of bibliographers. It has no number to correlate it with other Memoirs of the Geological Survey, past or future; it has no index; and the plates bear no legend to indicate their place of origin.

W. T. Calman.

II.—Palæozoic Strata of Charkow, Russia.

Das Palaeozoicum im Isjumer Kreise des Governements Charkow. [The Palæozoic Strata of the Isjumer District in the Province of Charkow, Russia.] By N. Yakowlew. Mém. du com. géolog., St. Pétersbourg, 1908 (pp. 1–29).

THE researches of W. Nalivkin and A. Borissiak dealt with the Palæozoic of the Isjumer district as an undivided whole. The present work attempts a subdivision of the Palæozoic of that neighbourhood, and deals especially with the salt-bearing deposits. The Upper Palæozoic strata belong to the highest beds of the Donjetz Palæozoic, and are divisible from above downwards into the following:

1. Salt-bearing group, with the salt deposits of Slawjansk, Bachmut, etc.
2. Dolomite group, with clays, dolomite, limestone, and gypsum.
3. Group of sandstones (occasionally containing copper) and "Schiefer-Kupfersandstein-Complex [Group]".
4. Araucariten group, sandstones and slates with intercalated grey, clayey, and unfossiliferous limestones.
5. Unproductive Carboniferous.
6. Productive Carboniferous, the top beds only being probably exposed.

Beds 1 to 4 are placed in the Permo-Carboniferous, while 5 and 6 are included in the Upper Carboniferous. The author differs from the previous investigators in some of the explanations offered for the tectonic features. The theory given for the formation of the rock-salt deposits in a narrow arm of the sea corresponds to that put forward by Ochsenius. An explanatory map of the locality accompanies the paper.

I. T.

III.—Geology of Egypt.

IN an essay on "The South-western Desert of Egypt", published in the *Cairo Scientific Journal* (vol. ii, August and September, 1908), Dr. W. F. Hume gives some account of the progress of the Geological Survey of Egypt since its establishment in October, 1896, and of the problems that remain to be solved. Already it has been possible to prepare a general geological map of the country, despite the fact that there have never been more than five workers in any one year, and that in many cases they have had to construct their own topographic maps. Naturally there is much yet to be done before even the general picture of the geology can be satisfactorily completed.

Among areas at present unsurveyed in detail is the great South-western Desert, beyond Dush in the Kharga Oasis, and in the present essay Dr. Hume gives the results of an expedition undertaken with the object of ascertaining the nature and trend of the rocks, the movements by which they have been affected, and their economic resources.

The Fundamental Strata comprise granites seamed by dykes of dolerite and felsite, gneisses, and schists, and these are overlaid by thick beds of Nubian Sandstone, which contain materials derived from the destruction of the older crystalline rocks, in the shape of coarse pebbles of quartz and felspar in the lower portions and white sands in the upper. The still newer strata comprise the Campanian and Danian of the Upper Cretaceous and the Libyan Beds of the Lower Eocene, the succession agreeing with that observed elsewhere in Egypt.

Attention is drawn to evidence of considerable movements resulting in almost symmetrical oval basins or centroclinal folds. The Fundamental Strata which are at or very near the surface "have very definite relationships, both to the centroclinal basins of the sedimentary strata and to the bends in the cliff-wall of the plateau, these all lying along definite lines, trending east and west". Thus "it will be noted that the rectangular bends of the plateau, the granitic masses, and the centroclinal basins of Eocene and Cretaceous rocks tend to fall in definite lines, the granitic masses surrounded by the dipping sandstone being the domes, and the Eocene-Cretaceous exposures being the basins due to the double movement".

Referring to these movements of upheaval, Dr. Hume remarks that "when such folds take place the convex portions or anticlines first become subject to erosion by the sea as they tend to rise above the waves, the elevation and denudation being probably simultaneous". In this way the origin of the depressions through subsequent erosion of the softer strata, and their influence on the formation of oases, are discussed. The smaller oases occur, in the main, at the junction of the hard and practically impermeable limestone of the Campanian with the white limestone of the Danian; while the greater oases are found in the underlying Nubian Sandstone, the water being upheld by clayey layers which are intercalated in the strata.

IV.—The Geology and Scenery of the Grampians and the Valley of Strathmore. By Peter Macnair, F.R.S.E., F.G.S., Curator of the Natural History Collections in the Glasgow Museums, etc. 2 vols. pp. xiv + 195 and xii + 199, with 163 plates and 10 folded and coloured maps and diagrams. 8vo. James MacLehose & Sons, Glasgow.

(*Concluded from January Number, p.* 35.)

In the fifth chapter, on the schistose igneous rocks, the sill-like forms of basic rock, which occur amongst the schists of sedimentary origin, are dealt with first. There is much reference to ancient views on the origin of these rocks, but the author fails to give a satisfactory account of their present structure, of the changes that they are thought to have gone through, or of their original constitution. The account of the general distribution of the sills is apparently taken from the publications of the Geological Survey, and Cunningham-Craig's description of the sill on Ben Vrackie is wrongly ascribed to Barrow. The description of the so-called 'older' granite of Ben Vuroch and of neighbouring masses is apparently drawn from the same source.

Chapter vi is devoted to a discussion of the structure of the southern Grampians. The author adopts the well-known theory of mountain building, which assumes a sinking geosynclinal area in which a thick mass of sediments is deposited. Through tangential earth-pressure the sediments are converted into a geanticlinal, compressed further and ultimately rucked up into a series of isoclinal folds, arranged in anticlinoria and synclinoria.

Applying this theory to the Highlands, the author finds that the main axis of upheaval of the range passes through the Ben Lawers ridge, and can be traced in a south-westerly direction into the district of Loch Awe. Along this line the axial planes of the folds are vertical, and on each side of it they dip in towards it. The dip of the limbs of the folds decreases as one recedes from the central line. It is noticeable that in this 'fan' the youngest beds lie in the central line, where, according to the theoretical 'fan,' the oldest beds should crop out.

The author describes in some detail numerous sections taken from the central 'fan' right across country to the southern border of the Highlands. These are thought to prove the existence of another great 'fan' named the "marginal *fächer*." A part only of this fan is preserved to us along the Firth of Clyde, since the Highland boundary fault runs obliquely across its northern limb and cuts it out completely in Perthshire. The axis of the intervening synclinorium is described as running up through Cowal, and after bending sharply eastward is thought to enter the boundary fault near Ben Venue. Along this axis the author believes that the beds are arranged in a synclinal double fold, and considers the anticline of bedding of the older geologists and the anticline of foliation described by Clough in the memoir on the Geology of Cowal to be entirely deceptive. We have failed, however, to find the double synclinal fold in the sections

provided. The structure there represented is on a large scale a gentle anticline of bedding.

In a short chapter concluding the first volume the author returns to a description of the narrow belt of cherts and black shales which crop out along the Highland border. Although the exact relation of these supposed Arenig rocks is left as an open question, he can find no justification for separating these rocks, at any rate as seen in Perthshire, from the crystalline schists of the Highlands.

The second volume opens with an interesting description of the Lower Old Red Sandstone of Strathmore, the stratigraphy and structure being written up mainly from the papers of Jack & Etheridge and Du Toit. The plant and fish remains are also described and illustrated. The Upper Old Red Sandstone, which rests with a violent unconformity on the Lower, occurs only in small patches, sometimes preserved between trough-faults. The interesting outlier of Lower Carboniferous rocks near Dron, proving the former extension of the Carboniferous rocks north of the Ochil Hills, is also noticed.

In the following chapter the author attempts to prove that the Old Red Sandstone was laid down in the sea. In this few geologists will agree with him, though it be not difficult to find objections to the generally accepted lacustrine theory. His chief argument is that if the Lower Old Red Sandstone were to be replaced in the position it occupied before the faulting along the Highland border took place, it would pass completely over the Highland hills even though they were four times their present height. Further, that the position of outlying masses upon the dividing ridge makes it difficult to believe that the lake basins were separate and yet contemporaneous. The argument that the 'Orcadian' and 'Caledonian' cannot be contemporaneous, because the former does not contain a volcanic horizon, is one which is difficult to follow. Other reasons given are, to say the least, curious. Thus, nothing will persuade the author that the Lorne basin is other than an outlier, because the boulders in its conglomerates are so large as to preclude the possibility of its being formed in a basin only a few miles wide (p. 29). The chemical difficulty in the precipitation of red oxides of iron in the ocean is ignored, and the attempt to bolster up his theory by an appeal to the palæontological evidence is altogether unconvincing. After the study which terrestrial accumulations have received in recent years, those geologists who find difficulties in accepting the lacustrine theory will be ready to admit that much of the Old Red Sandstone may have been formed under certain continental conditions, but few, if any, will find satisfaction in the marine theory.

Chapter x contains a description of the unfoliated plutonic rocks and dykes intruded into the Highland schists. These include the well-known igneous complex of Garabal Hill, the plutonic rocks of Carn Chois, and a small intrusion situated on the eastern shore of Loch Tay. Short notices follow on various sills and dykes of quartz-porphyry, felsite, and lamprophyre.

The following chapter treats of the volcanic rocks of Lower Old Red Sandstone age, which form the Sidlaw and Ochil Hills. These

ranges form respectively the northern and southern limbs of a faulted and denuded anticline. The lavas are also associated with the Lower Old Red conglomerates, which rest on the Highland schists.

Chapter xii, on the dolerite dykes, which traverse the rocks of Highlands and Lowlands alike, is illustrated by a number of good photographs of these intrusions. The author is inclined to think that the large dolerite dykes of Perthshire, trending nearly east and west, are of late Carboniferous age, whilst those with a north-westerly trend, occurring mainly in the western districts, are undoubtedly a continuation of the Tertiary dykes of the Western Isles.

The succeeding chapter is devoted to a sketch of the glaciation of the whole region. The ordinary phenomena—rock striations, boulder-clay, erratic blocks, moraines, rock-basins, raised beaches, and forest beds—are taken up seriatim and local examples cited. On the question of interglacial periods we find the indefiniteness, coupled with more or less contradictory statements, which we have had to remark on previously. First, we read that there are at least two great phases, an older period of general glaciation and a later period of valley glaciers. Further on (p. 111) beds of sand, gravel, fine clay, and layers of peat intercalated in the boulder-clay, are quoted as evidence of the great changes of climate, and proof that the boulder-clay is not one continuous deposit. "In the one case we have a state of matters where no life is possible, away down in the depths of the ice, where there is no sound but the sound of the river of ice and rock, an incessant, hollow, monotonous grind; in the other we have light and heat, the brightness of sunshine with all the cheerfulness and beauty which it brings, the flutter of forest leaves, the song of birds, the hum of the busy insect's wing, and even, perchance, in the later of these periods, suggestions of the presence of man." How many interglacial periods are represented between the bottom and top of the boulder-clay? The localities where the layers of peat in the boulder-clay are found are not mentioned. We could understand the author arguing for the existence of an interglacial period between the deposition of the boulder-clay and the accumulation of the moraines at the mouths of the Highland glens, yet he states (p. 117) that "after the great ice-sheet passed away, local glaciers still continued to occupy the valleys", indicating therefore a continuity of glacial conditions. A remarkable confusion of personalities is caused by a large perched block near Callendar being called "Samson's putting stone" in the text and "The Deil's Puttin' Stane" in the photograph. The chapter finishes with some notes on the distribution of the so-called Alpine flora of the hill-tops. The author concludes that the strain-slip-cleavage of the Ben Lawers schist "has been a most important factor in determining the present existence of Alpine plants on these mountains".

A long description of the river-terraces of the Tay and Tummel, and a discussion of their origin, occupies the greater part of chapter xiv. It concludes with some notes on the silting up of lochs, on soils, and on peat.

In the final chapter, on the relation of the scenery to the geological structure, a summary of the geological history of the region is given

first. From this the author concludes that towards the close of the Carboniferous period a platform of highly convoluted Highland schists lay buried beneath a thick mantle of Old Red Sandstone and Carboniferous rocks, which rested upon the schists with a gentle slope to the south-east. The contorted Lower Palæozoic rocks of the Southern Uplands were hidden under a similar cover, whilst gently folded Upper Palæozoic rocks were faulted down between the Highland and Southern Upland boundary faults. The plane had a slope to the south-east which gave the initial direction to the primitive rivers. These rivers cut down into the schists beneath, and carved out the transverse valleys of the Southern Highlands, whilst the longitudinal valleys were formed by tributary streams eroding courses in the belts of softer rock. The initiation of the river-system is thus thrown back into late Palæozoic times, but further on the author uses the old argument from the disposition of the Tertiary dykes that the erosion of the Highland glens has been accomplished since Miocene times. What, then, was happening between late Carboniferous and the end of Miocene times? There is only the cutting through of the cover of Carboniferous and Old Red Sandstone rocks to fill up this vast interval. It would be much more plausible to assume that the river-system was initiated on a former cover of Mesozoic rocks. The origin ascribed to the longitudinal section of the Tay between Ballinluig and the head of Glen Dochart will probably give most readers the impression that this portion of the river originated as a strike stream of its present length, and merely cut down through the cover of Upper Palæozoic rocks and the weak schists of the Garnetiferous Schist zone, whereas an inspection of a good map shows that it must have cut back from the trunk stream and captured the head-waters of several transverse streams. The whole treatment of river development leaves much to be desired. The many interesting problems which this district offers for solution are barely indicated. Although the path of the Tay is followed in detail, the relation of this river to its tributary streams and to neighbouring river-systems is not touched upon. The other rivers are treated very briefly.

The author then proceeds to a long description of the ruggedness or smoothness of the hill-slopes in the various schist 'zones', and notes the scarped features of the Ochil and Sidlaw Hills. Defiles are mentioned as intersecting the former chain, but no explanation of them is offered. Except to claim the lake basins as the work of the ice-sheet, the influence of the glaciers of the Ice Age on the river-systems receives no consideration.

The work concludes with a short bibliography and an index. The text has been carefully corrected in the press and is practically free from typographical error. The label "Upper O.R.S." in fig. 10, vol. ii, is misplaced.

V.—Hints for Crystal Drawing. By Margaret Reeks. Longmans, Green, & Co. 3*s.* 6*d.*

THIS little book will prove a very welcome addition to the sources of information available to those beginning the study of crystallography. It is intended to show the student how to make

for himself drawings of crystals in clinographic projection, such as he sees—but does not always understand—in textbooks of mineralogy. The author uses graphical methods to solve the problems that arise in the pictorial representation of crystals, some of which are very ingenious and cannot fail to appeal to those numerous students who are not blessed with the mathematical faculty. In each system the mode of drawing the areas, in the conventional positions adopted by crystallographers, is first described, and then the methods of drawing around these the various simple forms either alone or in combination. The book is well illustrated by original drawings made by the author herself, and the text is written in a simple, clear, and refreshingly unacademic style. Anyone to whom the subject is new, who desires to obtain a clear idea of the geometrical side of crystallography, will find Miss Reeks's book most helpful.

C. G. C.

VI.—On the Evidence of the Origin, Age, and Alteration of the Rocks near Heathcote, Victoria. By Ernest W. Skeats, D.Sc., A.R.C.S., F.G.S. Proc. Roy. Soc. Victoria, vol. xxi (new series), pt. i, August, 1908.

THE area in question lies about 75 miles north of Melbourne. It consists of Silurian and Ordovician sediments, the former to the east, the latter to the west. (A part has even been regarded as Cambrian, by Etheridge.) Between these two areas of unaltered sedimentary rocks there occurs a zone of igneous rocks and associated "cherts and jasperoids", forming a linear outcrop some half a mile in width running roughly north and south across the district. The igneous materials are mainly diabases and diorites, but "microgranites, granophyres, and felspar porphyrites" also occur, especially in the immediate neighbourhood of Heathcote. The exact age of these igneous rocks and their relation to the adjacent sediments, and the true nature and mode of origin of the cherts and jasperoids, are controversial questions of long standing in Victorian geology. Professor Skeats's paper is a notable addition to those already contributed on the subject by Dunn, Lidgey, Howitt, Gregory, etc.

By some the diabases have been regarded as of intrusive, by others as of effusive origin, by some as of pre-Silurian, by others as of post-Silurian or even pre-Ordovician age. Professor Skeats gives his reasons for considering them to be effusive rocks of Lower Ordovician age. The paper, besides recording the results of the author's own field and laboratory work, includes also a review and discussion of the previous literature on the district. The following extract best expresses the author's views:—

"With regard to the conclusions at which I have arrived in this paper, I find myself only in partial agreement with previous workers.

"I am in agreement with Mr. Dunn in regarding the diabases as mainly effusive. With Professor Gregory I agree that the diabase is pre-Silurian, and with Dr. Howitt that the Ordovicians are altered along the contact with the diabase, and that the black cherts are altered Ordovician rocks. On the other hand, I disagree with

Dr. Howitt, who regarded the diabase as a rock intrusive in Devonian times. I regard it as mainly effusive in origin and probably of Lower Ordovician age. With Professor Gregory I am unable to agree in the interpretation of some of the field-evidence, and I differ from him in regarding the cherts as altered Ordovicians and the diabase as being probably Lower Ordovician in age, and in his interpretation of the relation of land and sea in Lower Ordovician times." A geological sketch-map illustrates the paper.

C. G. C.

REPORTS AND PROCEEDINGS.

Geological Society of London.

December 16, 1908.—Professor W. J. Sollas, LL.D., Sc.D., F.R.S., President, in the Chair.

The following communication was read:—

"On the Igneous and Associated Sedimentary Rocks of the Tourmakeady District (County Mayo)." By Charles Irving Gardiner, M.A., F.G.S., and Professor Sidney Hugh Reynolds, M.A., F.G.S. With a Palæontological Appendix by F. R. Cowper Reed, M.A., F.G.S.

The general succession of the Ordovician Rocks of the district appears to be as follows:—

(4) ? Bala Beds.—Coarse conglomerate and sandstone containing pebbles, mainly of granite and felsite.

(3) Llandeilo Beds.

(*c*) Shangort Beds.—Grits and tuffs, coarse and fine, the prevalent type being a calcareous gritty tuff, in which is a series of limestone breccias, having a maximum thickness of about 40 feet and largely formed of disrupted fragments of the underlying limestone.

(*b*) Tourmakeady Beds.—Compact pink, grey, or white limestones, sometimes in beds with a maximum thickness of about 30 feet, but usually represented by blocks in the Shangort Beds.

(*a*) Red felsite or rhyolite.—A series of flows varying much in thickness.

(2) Arenig Beds—Mount Partry Beds.

(*d*) Variable tuffs, grits, and cherts, the tuffs being seen only in the southern halt of the area.

(*c*) Coarse quartzose and felspathic grits.

(*b*) Grits, graptolitic black slates, and radiolarian cherts.

(*a*) Coarse conglomerates, the pebbles of which consist almost entirely of grit.

A considerable series of graptolites, collected from the Mount Partry Beds, has been examined by Miss G. L. Elles, D.Sc., and they prove to be of Upper Arenig age—about the zone of *Didymograptus hirundo*. The radiolaria from the same series of rocks have been studied by Dr. G. J. Hinde, F.R.S.

The most interesting and puzzling beds of the district are those of Llandeilo age. Although the limestones (Tourmakeady Beds) occur in the main as disrupted blocks in the gritty tuffs (Shangort Beds), the fossils indicate that there is no material difference in the age of these two deposits; and the authors believe that, after the deposition and consolidation of the limestone, but during the prevalence of the same faunal types as those which characterize that deposit, the limestone was broken up by volcanic explosions, and its fragments,

mingled with bits of felsite and other material, were deposited as the peculiar limestone breccias. This view regarding their formation is held to afford an adequate explanation of the patchy development of these rocks.

The intrusive rocks are of considerable interest. They are, in the main, felsites with large quartz-crystals, and not infrequently contain augite.. Some of them are certainly intrusive in the coarse Bala (?) conglomerate. A number of small but interesting intrusions of olivine dolerite, hornblende lamprophyre, and fine-grained oligoclase bearing rocks are scattered throughout the district.

The appendix embodies a critical review of the fauna of the Llandeilo Beds of the district, and a description of several new species of brachiopods and trilobites.

CORRESPONDENCE.

POST-GLACIAL CONDITIONS OF THE BRITISH ISLES, AND PRESENT GLACIAL PHENOMENA OBSERVED IN ANTARCTIC LANDS.

Sir,—Ever since the publication by Captain R. F. Scott of *The Voyage of the Discovery*, in which he gives his impressions of the Great Barrier discovered by Sir James Ross, we have been asked to suspend our judgment concerning its actual physical features. It is not quite clear what is now the uncertain feature in the minds of those who ask us to delay; but it would appear that this counsel results from a fear that if the conditions of the barrier are as stated it cannot be maintained that a similar ice-sheet did not once fill the area now occupied by the North Sea during the Ice Age.

To those who consider that the glacial phenomena of the British Isles prove that an ice-sheet did move from Scandinavia over the North Sea area and invade the east of England, the facts concerning the Great Barrier are of the highest importance.

Although there is abundant matter for further investigation in the Antarctic area, the facts put on record by Sir James Ross and Captain Scott are sufficient, I think, to warrant my calling attention to their great interest to the glacial geologist.

From about 71° S. lat. to about 83° S. lat. and 167° E. long. a range of snow- and ice-covered mountains runs in the direction of the South Pole. Some of the summits exceed 15,000 feet in height, and the range forms, for at least 800 miles, the eastern boundary of South Victoria Land. It rises abruptly from the ice-covered sea. About the centre of the known portion of this great mountain range is the active volcanic cone of Mount Erebus. It is not, however, actually a portion of the range, for it stands on an island close to the shore.

From Erebus stretches the Great Barrier in an easterly direction. This 'wall of ice', which faces the open sea, varies in height from 50 to 240 feet and extends as far as King Edward VII Land, a distance of about 390 miles. The depth of the sea along its edge, according to

Ross and Scott, varies from 1,500 to 2,700 feet. If the submerged ice is six times the thickness of the portion above the sea-level, the depth of the barrier in the sea must vary from 300 to 1,440 feet. There is, therefore, in many places more than 1,000 feet of water between the sea-bottom, for the thin ice is frequently above the deep water. The ice of the barrier, except at its ends, is floating along its whole front. On this matter Sir James Ross says: "Whilst waiting we obtained soundings in two hundred and thirty fathoms, the deep sea clamms bringing up some green mud intermixed with small volcanic stones. This depth of water would seem to prove that the outer edge of the barrier was not resting upon the ground; for by various measurements of its highest part it was found to be one hundred and seven feet above the sea, from which point it gradually diminished for about ten miles to the eastward, where it could not have been more than eighty feet." Here there was, therefore, about 1,100 feet of water under the ice. Captain Scott found that the edge of the ice when he sailed along it was about 30 miles further south and the sea quite as deep. The statement made by Ross that the barrier was floating must, consequently, have been quite correct. At Balcon Inlet, near the eastern edge of the barrier, Captain Scott noticed that a small "berg, as well as the pack ice which had been driven in by the current, took its way out to sea again, clearly showing that there is a regular tidal stream in this region, and as, in spite of this, we and the barrier ice about us rose and fell together, there was no doubt that at least this part of the barrier was afloat".

But Scott travelled south over the barrier ice until he was about 300 miles from its face, and his observations showed that he had travelled over a comparatively level plain all the way, the ice being of nearly uniform thickness, his opinion being that the "Great Barrier ice-sheet is afloat at least as far south as we travelled". He also remarks: "I still hold that the greater part of it is afloat; and strange as it is to imagine that the sea should run beneath such a solid sheet for so many hundreds of miles, I have yet to learn any reasonable argument against such an idea." I am here in complete accord with Captain Scott, and think that his reasoning is quite unanswerable. Ice behaves as a very viscous liquid, and may rest upon and slowly spread over water, a tendency to spread resulting from the fact that a portion of it stands above the sea-level.

As it is possible for an ice-sheet such as that which Ross and Scott described to maintain itself when exposed to the open Pacific, it is also possible for a similar ice-sheet to maintain itself in the North Sea during a glacial epoch, this sea facing the cold north instead of the open warm sea.

It is argued without any clear reason being given that an ice-sheet could not cross the deep channel near the Scandinavian Peninsula. I do not think that this is a real difficulty. In the first place, the moderately thick ice lobes would float across the channel, and when they touched the sea-bottom on the opposite side the ice over the channel would thicken. This thickening and consequent rise above the sea-level would furnish the necessary gradient to force the ice towards Great Britain. The distance the ice would travel would

depend upon the supply of snow, and eventually the deep channel might be filled with ice to the bottom.—Yours truly,

R. M. Deeley.

Melbourne House, Osmaston Road, Derby.
January 11, 1909.

PEARL FROM THE CHALK.

Sir,—The interesting notice of Mr. Newton's paper on Chalk Pearls in your January number recalled to my memory that I still possessed the original pearl from which Mr. B. B. Woodward's section was cut. Singularly enough the circumstance had entirely escaped the memory of both of us until your notice referred me to Mr. Newton's figure and allowed me to recognize the section and the pearl as one and the same specimen. Following Mr. Woodward's example I have had the pleasure of presenting the larger half of the pearl to the British Museum (Natural History), so they can in future be inspected in the Geological Department.

G. E. Dibley.

46, Burghill Road, Sydenham, S.E.
January 13, 1909.

FLINTS IN THE DRIFT.

Sir,—I am delighted to learn from Dr. Bather's note in your January issue (p. 47) that flints are as abundant in Denmark as in East Anglia, and doubtless the prehistoric Danes made their implements from their own chalk-flints. If the word 'pink' is inserted before the word 'flint' in line 9 of my previous letter (see Geol. Mag., 1908, p. 575), it will, I think, be in order. In the Trans. Hull Geol. Soc., 1902 (vol. v, pt. ii, p. 31), Mr. J. W. Stather writes:—"Following Mr. C. Reid's surmise in the Holderness Memoir, we have become accustomed to regard Denmark as the source of the *pink* flints, common in the Boulder clays of Holderness. This is an error, as Mr. A. Jessen, of the Danish Geological Survey, recently informed the secretary that *pink* flints do not occur either in the Cretaceous Rocks or the drifts of Denmark, and are quite unknown there."

T. Sheppard.

THE DISCUSSIONS AT THE GEOLOGICAL SOCIETY.

Sir,—Though I have never had the pleasure of hearing a discussion at the Geological Society, and do not know how closely the views expressed there in full agree with the brief report subsequently given, I should be glad if I might be allowed to make a suggestion.

The publication of the discussion in the proceedings adds considerably to the interest of papers to Fellows who, like myself, are unable to attend the meetings. But the question I wish to ask is whether their usefulness does not stop at this point? There are, of course, cases when a paper deals with a subject closely studied by those present, and when even criticisms that are hastily composed may have a value. There are other cases when the subject-matter

is less familiar and a paper may suffer harm from unstudied remarks. Indeed, the value of the Quarterly Journal may be lessened by the insertion of such criticisms, which the Editor can hardly in fairness eliminate.

My suggestion is that the publication of the discussions should be limited to the Proceedings. The papers published in the Journal, usually the result of years of work, would not then suffer by juxtaposition with remarks composed at a few minutes' notice, and the Proceedings would have a more lasting value. Personally, I should like to see their interest and value still further increased (and the bulk of the Journal diminished) by the inclusion in the Proceedings of the President's address, the Report of the Council, etc.

Charles Davison.

16, Manor Road, Edgbaston, Birmingham.

THE PAST PRESIDENTS OF THE GEOLOGICAL SOCIETY.

Sir,—My attention has been called to an error in the printed report of an address I delivered to the Geologists' Association last February on "The Centenary of the Geological Society", which I shall be glad if you will allow me to correct. On p. 369 of the Proceedings of the Geologists' Association, vol. xx, the statement occurs: "Since Forbes's day no President has been elected under 50, with the exception of Dr. Marr, who was 47." This should read as follows: "Since Forbes's day no President has been elected under 40, and during the last twenty years none under 50, with the exception of Dr. Marr, who was 47." The mistake arose through a line being dropped in transcribing my notes, and it escaped attention while passing through the press. As a matter of fact, there were seven Presidents of the Society under 50 between Forbes and Dr. Marr, viz., Hamilton (first term), Sharpe, Ramsay, Smyth, Huxley, the Duke of Argyll, and Professor Judd. While on this subject I may note that the oldest President was Leonard Horner, who when elected for his second term was 75.

Perhaps I may also be allowed to remind your readers that the recent election of Sir Archibald Geikie to the Presidential Chair of the Royal Society adds a third name to those I have mentioned on the above-quoted page of my address (Lord Northampton and Huxley) who have served as Presidents both of the Royal and Geological Societies.

R. S. Herries.

5, New Street Square, E.C.

THE BURNING CLIFF NEAR LYME REGIS.

Sir,—Now that the spontaneous combustion at the Lyme Regis end of Black Ven has been mentioned in your pages, I beg to be allowed to point out a possible source of misconception to visitant geologists as to the extent of the burning. But first let me make it clear that my statement is only hearsay, and may be mere gossip; for

being otherwise busied at the time, I was unable to investigate the matter. Its bearing, however, on the magnitude of the effect in this instance of what is an established natural phenomenon is obvious and for that reason considerable.

The cliff took fire early in 1908. Notices, descriptions, and explanations appeared in various papers, local and otherwise, and enterprising shopkeepers in Lyme took photos and exhibited them as picture postcards, which they sold as mementos of 'the volcano'. The advertisement attracted visitors to Lyme, and evidently the burning cliff was a source of profit to the Lyme folk. In Charmouth, during April, 1908, it was common talk that when the 'volcanic' activity appeared to be subsiding, disappointed Lyme people poured paraffin on the cliff and relighted it. It is probable that, saturated with enough paraffin, any clay cliff would burn when lighted, and the effect would be commensurate with the amount of oil used. If paraffin was poured on the burning part of Black Ven, it has made it impossible to judge the extent of the natural combustion and of its effects. Last April a beautiful specimen of burnt red shale was in the Coach and Horses Hotel at Charmouth, but the interest it would naturally have evoked was spoiled by the suspicion that it was the result not of the heated behaviour of Black Ven, but of the commercial ardour of Lyme speculators. It would be interesting if a future Lyme visitor would investigate the report and establish the truth. In August last the Charmouth world said that the Lyme people had over-reached themselves, and had made so much of the 'volcano' that intending visitors stayed away through fear. This sounds so unlikely that one is inclined to doubt the truth of the paraffin statement.

With apologies for much gossip, even though it contains a warning,

PASSER VENNENSIS.

OBITUARY.

JOSEPH LOMAS, F.G.S.

BORN NOVEMBER 18, 1860. DIED DECEMBER 17, 1908.

MR. JOSEPH LOMAS, whose sad and premature death we recorded last month, was born at Bugsworth, on the borders of the Derbyshire Peak district, on November 18, 1860. He received his scientific education at the Royal College of Science under Professors Huxley, Judd, and others. In 1885 he was appointed to organize and conduct the teaching of science in the elementary public schools of Liverpool under the School Board, and he was professionally occupied with that work until the end. During his later years he was also a successful "Special Lecturer" in Geology in the University of Liverpool, which still has no professor of this important branch of science.

Though equally well trained as a zoologist and as a geologist, Lomas was inclined chiefly towards researches of a geological nature. His most important early work related to questions of Glacial Geology, which he attempted to solve by visits to Switzerland and the Faröe

Islands. He also wrote petrological papers. He joined the Liverpool Marine Biology Committee, and reported on the deposits found on the bed of the Irish Sea, comparing these with older geological formations. During later years, under the auspices of the British Association, most of his leisure was devoted to the study of the British Trias and a comparison of it with modern deserts. In 1905 he visited some of the desert regions in South Africa and Egypt, and when he met his death by accident in December last he was extending his researches to the region round Biskra in Algeria.

For many years Lomas was a well-known leader of field excursions, and he organized the excursion of the Geologists' Association to the Berwyn district of Wales last summer. He was also an active member of the British Association, and had been for several years Recorder of Section C (Geology). His personal charm and good nature and his enthusiastic cheerful manner endeared him to a large circle of friends, who mourn his unexpectedly early loss. The Geological Society of London acknowledged his scientific worth by the award to him of part of the Lyell Fund in 1897; while the Geological Society of Liverpool honoured him by election for two terms to its Presidential chair.

Mr. Lomas was a frequent writer on geological subjects. His separately published papers amount to seventy-two in number, thirty-one being read before the Liverpool Geological Society, twenty-four before the British Association, nine in the GEOLOGICAL MAGAZINE, and the rest read before various local scientific societies, that on existing Deserts compared with the British Trias (see GEOL. MAG., 1907, pp. 511 and 554) being one of the most important.

J. S. GRANT WILSON.

BORN JUNE 2, 1855. DIED DECEMBER 29, 1908.

WE regret to record the death of Mr. J. S. Grant Wilson on December 29 after thirty-two years' service on the Scottish Staff of the Geological Survey. After completing his education at St. Andrews University, where he carried out a series of analyses of minerals in the chemical laboratory under the supervision of the late Professor Heddle, he joined the Geological Survey in 1876. He received his first instruction in field mapping under Dr. B. N. Peach and Dr. Logan Jack when they were engaged in surveying the Silurian, Old Red Sandstone, and Carboniferous Rocks of the border territory in Eskdale and Liddesdale.

During his official career it fell to his lot to map large areas of crystalline schists in Banffshire, the north-east of Aberdeenshire, Central Perthshire, the fascinating region on either side of Ben Nevis, and part of the Knapdale plateau in Argyllshire.

While prosecuting his operations in the field in Perthshire he made a careful series of soundings in Lochs Tay, Earn, and Tummel, the results of which were published in *The Scottish Geographical Magazine* for May, 1888. His results agree very closely with those obtained subsequently by the Scottish Lake Survey.

But his bent lay clearly towards the economic side of geology, and especially towards the important industry of the Scottish Coalfields. Hence, in anticipation of the new editions of the one-inch maps of the Fife Coalfield, he was entrusted with the task of revising parts of these Coalfield areas and obtaining information regarding mining and boring operations since the date of the original survey. His services in this connection were acknowledged by Sir Archibald Geikie in the two official memoirs which he wrote on the Geology of East and Central Fife. Since then he endeavoured to acquire an intimate knowledge of the development of the Fife Coalfield by gaining access to the journals of recent bores. Indeed, he obtained in a remarkable degree the confidence of those specially interested in this industry, in proof of which it may be mentioned that his opinion regarding the sites of new bores and the interpretation of geological horizons was much sought after in recent years. More recently Mr. Wilson re-examined the Carboniferous area of the Lothians and gave a concise description of the geology of the oil-shale fields, since published in a Survey Memoir.

His early chemical training was of service to the Geological Survey, for at intervals he carried out a series of chemical analyses of volcanic and plutonic rocks, of crystalline gneisses and schists, some of which have been published in *Ancient Volcanoes of Great Britain* by Sir Archibald Geikie, and in the recent memoir on "The Geological Structure of the North-West Highlands of Scotland". Since the institution of a chemical laboratory in the new office of the Scottish Survey, he has made a series of analyses of Carboniferous limestones from the midland valley of Scotland.

J. H.

SIR THOMAS WARDLE, J.P., F.G.S., F.C.S.

Born January 26, 1831. Died January 3, 1909.

Sir Thomas Wardle, who was a silk dyer and calico printer at Leek, and for many years President of the Silk Association of Great Britain and Ireland, was also an active member of the North Staffordshire Field Club, to which he had contributed geological papers. He was best known to geologists as author of *The Geology of the Neighbourhood of Leek, Staffordshire*, 1863. In 1890 he acted as one of the directors on the excursion of the Geologists' Association to North Staffordshire, and conducted the party to the Yoredale Rocks of Butterton Moor, where attention was called to the hard calciferous gritstones, which he regarded as "theoretically the best road-forming rocks" (Proc. Geol. Assoc., vol. xi, p. cxxxii).

HENRY MEYNERS BERNARD, M.A., F.L.S., F.Z.S.

Born November 29, 1853. Died January 4, 1909.

The death of Henry M. Bernard removes from our midst a friend and fellow-worker who will be greatly missed by a large circle of men of science. Mr. Bernard took mathematical honours at Cambridge as B.A. in 1876, and entered the Church, his last charge being a Chaplaincy at

Moscow, which he left in 1888 in order to study Biology under Haeckel at Jena. In 1892 Mr. Bernard published an important monograph on "The Apodidæ", his study of these forms leading to papers in the GEOLOGICAL MAGAZINE in 1894 and 1895 on the systematic position of the Trilobites, and on 'the Sandblast' as a method of developing these organisms from the rocks in which they are embedded. In 1894 he began the study of the Recent and Fossil Corals at the British Museum (Natural History), continuing the quarto illustrated Catalogue of the Madreporaria (published by order of the Trustees) originally commenced by the late Mr. George Brook. In this work Mr. Bernard paid much attention to the fossil forms. He continued to work at the corals in the British Museum until 1907. During these thirteen years he prepared five volumes, namely:—

Vol. II of the Catalogue (begun by Mr. Brook) on the *Turbinaria* and *Astræopora*.
,, III, on the *Montiporina*.
,, IV, ,, *Goniopora*.
,, V, ,, *Porites* (Indo-Pacific).
,, VI, ,, *Porites* (West Indies) and *Goniopora*.

OTHER GEOLOGICAL PAPERS BY H. M. BERNARD.

1893. Trilobites with Antennæ at last. (*Nature*.)
1894. Systematic Position of the Trilobites. (GEOL. MAG., 1894, p. 230; 1895, p. 280.)
Systematic Position of the Trilobites. (Quart. Journ. Geol. Soc., vol. l, p. 411.)
Trilobites developed by the Sandblast. (GEOL. MAG., 1894, p. 553.)
1895. The Zoological Position of the Trilobites. (*Science Progress*.)
1897. Fossil Apodidæ. (*Natural Science*.)
On the Affinities of the Madreporarian genus *Alveopora* with the Palæozoic Favositidæ. (Journ. Linnean Soc., Zool.)

He died at 109, West End Lane, London, N.W., on January 4.

PROFESSOR H. G. SEELEY, F.R.S., F.L.S., F.G.S., F.Z.S., F.R.G.S., FELLOW OF KING'S COLLEGE, LONDON.

BORN FEBRUARY 18, 1839. DIED JANUARY 8, 1909.

WE regret to announce the death of Harry Govier Seeley, Professor of Geology, Geography, and Mineralogy in King's College, London, and member of the Athenæum Club, which occurred early on January 8 at his residence, 3, Holland Park Court, Holland Park Gardens, W. In June, 1907, we published a life of this able and distinguished worker in the GEOLOGICAL MAGAZINE, in our series of "Eminent Living Geologists" (pp. 241–53), accompanied by a portrait and a list of his numerous publications.

In addition to his arduous labours as a professor in King's College, Queen's College, and the Royal Indian Engineering College at Cooper's Hill, he will be best remembered, perhaps, for the wonderful collections he made in the Karroo Beds of South Africa and the resulting exhibition in the Natural History branch of the British Museum of the remarkable skeleton of *Pariasaurus* and numerous other Anomodont reptiles, which occupied years of patient

work in their development (under Professor Seeley's almost daily superintendence) by Mr. Richard Hall's and the Barlows' unwearied labours. These are a monument alone to his memory which can never be forgotten.

MISCELLANEOUS.

The Messina Earthquake.

The earthquake which at the close of last year devastated Messina in Sicily and Reggio in Calabria, on the opposite shores of the Straits in Southern Italy, is one of the most terrible and disastrous on record. We gather the following particulars from the *Times* (Weekly Edition, January 1, 1909):—

"The actual time of the earthquake seems to have been 5.20 on Monday morning, December 28. The first intimation, according to reports from Catanzaro and by fugitives from other places, was a prolonged, thunderous noise followed by a vivid flash of lightning and at the same time by a series of violent shocks which seemed interminable. Heavy torrential rain then fell.

"The second shock was at 9.30 in the evening of the same day, but it was less violent in character.

"There was a violent shock at San Marco Argentino on Tuesday night, accompanied by prolonged subterranean thunder. Many houses were damaged.

"A slight shock was felt at Palermo on Wednesday morning.

"Messina has been almost totally destroyed by the earthquake and the following upheaval of the sea. The worst damage was done by a vast wave, which has left the whole front of the town facing the sea in ruins. Fires broke out in many parts of the city and added to the difficulty of saving the innumerable persons who had been buried alive.

"Reggio, on the Italian side of the Strait, has also practically perished, and the whole shape of the coastline at that point has been altered. The sea front has been completely swept away, while the water in shore was blocked with sunken débris, foundered vessels, and every imaginable sort of obstruction. For a radius of 11 miles the country had a torn and twisted appearance, roads, bridges, footpaths, and railway lines being uprooted.

"The whole area of the ground below Reggio seemed to have turned over, and a great part of the city was in ruins, covered by the sea. In many places deep chasms appeared in the streets. Of all the villages looking towards Reggio on the coast, not one has been left standing.

"Most of the coast towns on both sides of the Strait of Messina have been wholly or partially destroyed.

"A rough estimate of the number of lives lost places it as more than 100,000 in Messina alone, while the destruction of property has been enormous."

Lyell, in his graphic account of the Calabrian Earthquake of 1783, stated that "The shocks began in February [of that year], and lasted for nearly four years, to the end of 1786".[1] These remarks and the subsequent history of the affected area do not lend encouragement to future enterprise.

Suess has observed in reference to the area of disturbance that "the crust of the earth has sunk down in the form of a dish, and thus radial fractures have been produced, which converge to the Lipari Isles. These converging lines are beset with volcanos near their

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centre of origin. Any disturbance in the equilibrium of the several fragments of the crust gives rise to increased volcanic activity on the islands, and to earthquakes on the mainland or in Sicily".[1]

Further subsidence in the future is not improbable. At present there are symptoms of activity in Stromboli.

The Royal Society.—On November 30, St. Andrew's Day, 1908, Sir Archibald Geikie, K.C.B., was elected President of the Royal Society. It is satisfactory to find that Geology as a distinct science has been recognized in this way, although it appears surprising that Lyell, in his time, had never been chosen. Of previous Presidents Wollaston had been a Vice-President of the Geological Society and he founded its Wollaston Medal, Sir Humphry Davy had been a Founder of the Society and Vice-President, Davies Gilbert had been a Vice-President, the second Marquis of Northampton (then Earl Compton) and Huxley had been Presidents of the Geological Society.

Appointment of a Keeper of Zoology in the British Museum (Natural History), Cromwell Road, London.—This office, which since the retirement of Dr. A. Günther, F.R.S., in 1895, was *temporarily* attached (*without salary*) to the post of Director of the Museum, first under Sir William H. Flower, K.C.B., from 1895–8, and afterwards under Professor (now Sir) E. Ray Lankester, K.C.B., from 1898–1907, has at length been filled by the appointment of Dr. Sidney F. Harmer, M.A., F.R.S., Fellow of King's College, Cambridge, and Superintendent of the University Museum of Zoology. Dr. Harmer has already done excellent work in Zoology, and being now only in his 46th year, if his health and courage do not fail him, may look forward to twenty years' service under the Trustees in the National Museum.

We regret to learn that the important post of Director, created by Parliament in 1856, and held successively by Owen (1856–84), Flower (1884–98), Lankester (1898–1907) for a period of fifty-one years, has now remained vacant for two years. Surely the Trustees need not be at a loss to find an able Biologist in this country to fill the office, or is it to be abolished on economic grounds?

The New Director of the Welsh National Museum, Cardiff.—At a meeting at Cardiff on Saturday, December 5, 1908, of the Welsh National Museum Council, Sir Alfred Thomas, M.P., presiding, Dr. W. E. Hoyle, Director of the Manchester Museum and lecturer in the University of Manchester, was appointed Director of the National Museum of Wales at a salary of £700 per annum. Dr. Hoyle will commence his duties not later than March 25, 1909.—*Daily News*, December 7, 1908.

Micrasters.—Many workers in the Chalk having expressed a desire to examine critically the series of Micrasters shown in the Science Gallery of the Franco-British Exhibition, the owners have, with the

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kind permission of Dr. Smith Woodward, Keeper of the Geological Department, agreed to allow them to remain in his charge for six months. Dr. Smith Woodward will therefore arrange for any serious student to have access to them on any week-day between the hours of 10 and 4 at the British Museum (Natural History), Cromwell Road, S.W.

Dew-ponds.—Mr. E. A. Martin, who has given great attention to the subject, summarizes our knowledge in an article "Some Considerations concerning Dew-ponds" (reprinted from the Trans. of the S.E. Union of Scientific Societies, 1908). The methods of construction of dew-ponds, their position, and other circumstances attending them are pointed out. As the author has previously maintained, the supply of water cannot be attributed wholly nor even principally to the deposition of dew; mist appears to be the most important source, and deposition of moisture is also favoured in some situations by trees and other forms of vegetation.

Geologists' Association.—The jubilee of this Society occurred on Sunday, November 29, and arrangements were made to celebrate it by a Conversazione at University College, Gower Street, on Friday, November 27, the nearest appropriate date; and by visits to the British Museum of Natural History and to the Museum of Practical Geology, followed by a dinner, on the Saturday. To mark the completion of their fiftieth year the Association have arranged to issue a volume dealing with the Geology of the Districts of England and Wales visited by them since 1858, the subjects to be treated from the standpoint of our present knowledge.

Geological Survey. — Dr. Aubrey Strahan, F.R.S., has been appointed Assistant Director (for England and Wales) in the room of Mr. H. B. Woodward, who retired on December 31, 1908. Mr. George Barrow, F.G.S., has been promoted to the rank of District Geologist.

Awards of Medals and Funds, Geological Society. — The Geological Society of London will this year award its medals and funds as follows:—Wollaston Medal to Mr. Horace B. Woodward, F.R.S.; Wollaston Fund to Mr. Arthur J. C. Molyneux (Rhodesia); Murchison Medal to Professor Grenville A. J. Cole; Murchison Fund to Mr. James V. Elsden, B.Sc.; Lyell Medal to Professor Percy F. Kendall; Lyell Fund to Mr. R. G. Carruthers and Mr. Herbert Brantwood Muff; Bigsby Medal to Dr. John Smith Flett; Prestwich Medal to Lady Evans.

Death of Lady Warington Smyth.—We regret to record the death of Lady Smyth.—On the 24th January, at her residence, West Cliff, Marazion, in the 82nd year of her age, Anna Maria Antonia, widow of the late Sir Warington W. Smyth, F.R.S., and daughter of the late Anthony M. R. Story-Maskelyne, F.R.S., of Basset Down, Wilts.—*Morning Post*, January 26, 1909.